DEPARTMENT OF AGRICULTURE AND WATER SUPPLY

ADMINISTRATION: HOUSE OF ASSEMBLY

ANNUAL REPORT

1 April 1985 to 31 March 1986

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REPUBLIC OF SOUTH AFRICA

ANNUAL REPORT

of the

Superintendent-General of the Department of Agriculture and Water Supply for the period 1 April 1985 to 31 March 1986

Published by Authority

RP 51/1987

Selling price
(GST excluded)
Local **R1,80**
Other countries **R2,15**
Post free

Published by the Department of Agriculture and Water Supply and obtainable from the Directorate of Agricultural Information, Private Bag X144, Pretoria 0001

Printed in the Republic of South Africa by the Government Printer, Pretoria

1987

ISBN 0 621 10767 0

Report of the Superintendent-General of the Department of Agriculture and Water Supply for the period 1 April 1985 to 31 March 1986

THE HONOURABLE THE MINISTER OF AGRICULTURE,
PRETORIA

Sir,

I have the honour to submit herewith the Annual Report of the Department.

Dr D.J. Agenbach
Superintendent-General of the Department of Agriculture and Water Supply

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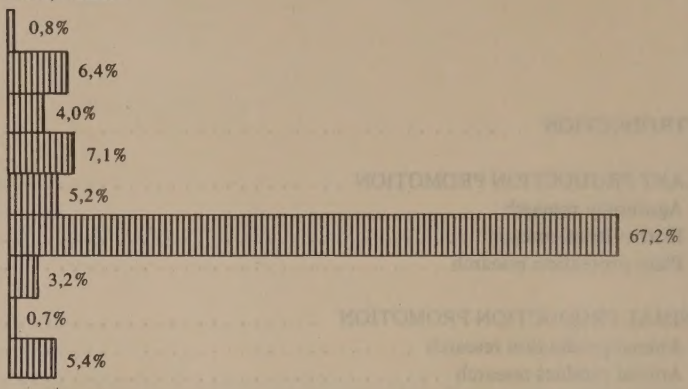
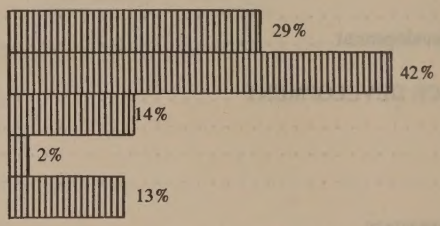
EXPENDITURE: 1 APRIL 1985 TO 31 MARCH 1986

TOTAL EXPENDITURE **R546,5 million**

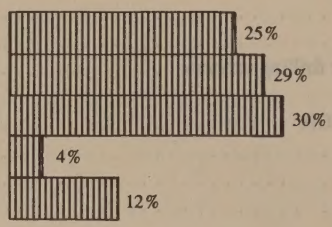


1. ADMINISTRATION (HEAD OFFICE) **R4,1 million**

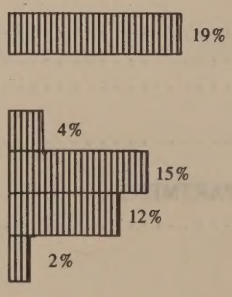
2. PLANT PRODUCTION PROMOTION **R35,6 million**

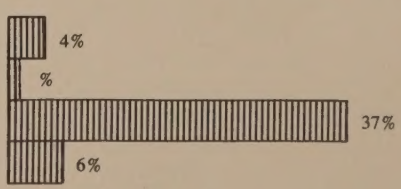


3. ANIMAL PRODUCTION PROMOTION **R22,1 million**

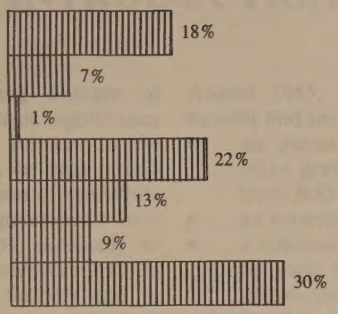


4. AGRICULTURAL RESOURCE UTILISATION **R39,5 million**

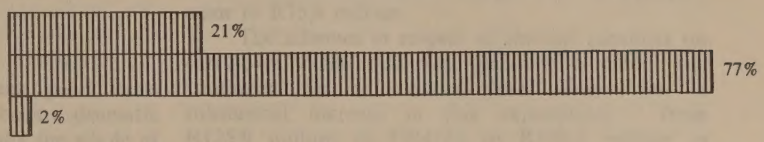




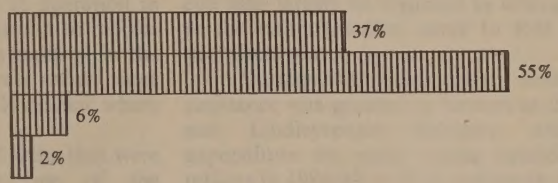
5. ENTREPRENEURS' DEVELOPMENT **R28,8 million**



6. AGRICULTURAL FINANCING **R368,1 million**

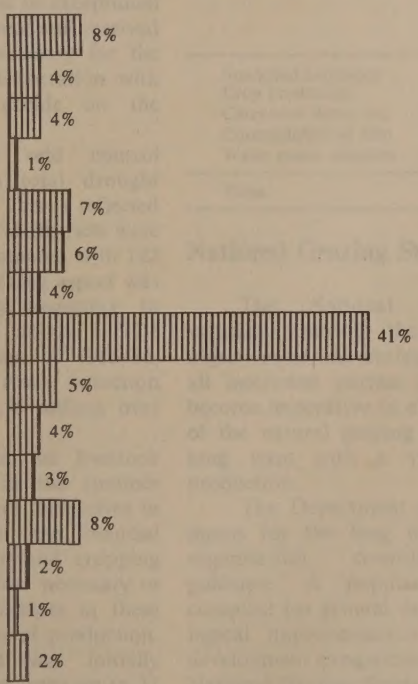


7. CREATION OF STATE SUPPORTED WATER SCHEMES **R18,1 million**



8. OPERATION OF STATE WATER SCHEMES **R4,3 million**

9. RELATED AND AUXILIARY SERVICES **R30,0 million**



INTRODUCTION

The effects of the devastating drought of the past few years brought the strategic significance of the South African agricultural industry to the attention of the entire population. In the light of this and with a view to the implementation of the White Paper on Agricultural Policy, the government over the past year took important steps, especially in respect of financing and optimum resource use, to stabilise the economic position of farmers and to save the country's pastures from ruin.

Emergency assistance

In the extensive grazing areas good rains relieved the drought and there has been a dramatic change in veld conditions over virtually the whole of the country. As a result of this it was decided to phase out as far as possible the phase assistance livestock grazing schemes that were in operation in the proclaimed disaster drought areas and to replace them with new schemes that were introduced in the livestock grazing and cropping areas after these proved successful in the Northern Transvaal where they were introduced on a trial basis.

It was initially decided that all areas that were proclaimed drought areas under one of the emergency assistance schemes or which were listed, would be delisted from 1 April 1986, and that all further drought assistance to livestock farmers would only be granted in terms of the Animal Grazing and Crop Schemes after farmers had re-applied. However, it soon became evident that in exceptional cases, where districts or portions thereof still received Phase 5 assistance, it would be necessary for the National Drought Committee, in deliberation with district drought committees, to decide on the continuation of such assistance.

As a result of improved veld control conditions, there was a drop in total drought assistance to the livestock industry. This is reflected by the fact that on 31 March 1986, 71 districts were listed as emergency grazing areas compared with 122 districts on 31 March 1985. A heartening aspect was that although the total emergency assistance to livestock farmers decreased from about R112,1 million in 1984/85 to R88,6 million in 1985/86, incentive payments in respect of stock reduction increased from R2,3 million to R6,75 million over the same period.

While emergency assistance in the livestock areas decreased slightly, farmers in the summer rainfall cropping areas not only found themselves in a continuing drought situation, but the financial deterioration - especially that of dryland cropping farmers - was striking. It was therefore necessary to continue emergency assistance to farmers in these areas, especially in respect of means of production. Where assistance in this regard was initially introduced only for a period of 12 months up to 31 August 1985, it was extended for a further 12 months and involved:

- an increase in the limit of crop production loans granted by the Agricultural Credit Board from R50 000 to R75 000 per calendar year
- an interest subsidy of 2% on such loans, and
- a concession that the loans could also partially be used for the payment of cash wages and maize-meal rations for full-time farm labourers.

Total expenditure in respect of assistance for means of production, including loans and rations, came to R75,8 million.

The schemes in respect of interest subsidies on carry-over debts and new production credit was continued for a another year. There was a substantial increase in this expenditure - from R125,9 million in 1984/85 to R199,0 million in 1985/86 - an increase of 57%.

Expenditure on consolidation of debts, which can also largely be regarded as emergency assistance to the farming sector, came to R44 million in the past fiscal year.

During the year under review emergency assistance was granted to farmers at the Kaffer River and Lindleyspoort Schemes, which increased expenditure on water quota subsidies from R2,3 million in 1984/85 to R2,6 million in 1985/86.

The table below is a summary of the assistance measures and indicates how contributions increased from 1979/80 to the present financial year. It reflects the effect of the drought and economic factors on agriculture.

	1979/80 (million R)	1985/86 (million R)
Stockfeed assistance	6,24	88,60
Crop production	9,75	75,80
Carry-over debts, etc.	1,30	199,00
Consolidation of debt	11,84	44,00
Water quota subsidies	-	2,60
Total	**R29,14**	**R410,00**

National Grazing Strategy

The National Grazing Strategy gained substance during the year under review. The objectives of this strategy imply that united action by all interested parties and the general public has become imperative to check the serious deterioration of the natural grazing and to improve it over the long term with a view to sustained increased production.

The Department made important and specific inputs for the long term in respect of planning, organisation, co-ordination, motivation and guidance. A popular working document was compiled for general departmental use to explain the logical implementation of the strategy. Regional development programmes giving high priority to the National Grazing Strategy were completed.

As procedural guideline the National Grazing Strategy was developed as an aid for the agricultural extension officer. Arising from this an extension manual was compiled and distributed among extension personnel throughout the country. Extension officers pursue the objectives of the Strategy according to the total-farm approach. These planned actions are embodied in the Regional development plans and have progressed well.

Regions enthusiastically began implementing extension programmes deferring to the broad objectives of the National Grazing Strategy. Regions made significant inputs by making farmers aware of grazing capacities and what this involves and the formulation of a technical/economic message.

A country-wide study was undertaken to determine the current perceptions of livestock farmers. The report is nearing completion. A survey was made in June 1985 to estimate the condition of the natural veld throughout the country. The grazing capacity map for the Republic was completed and it is now being refined.

A Pasture Research Working Group was created to advise on the co-ordination of research programmes within the Department and to lay down guidelines for co-operation with other institutions. The compilation of a national pasture research programme in which everyone involved can participate is in an advanced stage. There is strong emphasis on pasture research when contract research is allocated.

Existing curricula at colleges of agriculture are being revised and will in future be revised on a regular basis to comply with the demands of optimum resource use. Discussions with agricultural training institutions were also initiated.

The Department also appointed an advisory committee for pasture affairs to ensure that all concerned will have somewhere to turn to. The committee must advise the Minister and the Department on:

- matters concerning the use, conservation and development of grazing in the RSA
- the handling of identified problems in terms of research requirements, extension, regulatory services, training and legislation
- the formulation of proposals for the co-ordination of actions between all institutions concerned with pasture use and animal production, and
- any other relevant matter concerning the use, conservation and development of grazing and which, in the opinion of the committee, should be brought to the attention of the Minister and the Department.

The successful implementation of the National Grazing Strategy, that is the total recovery and reconstruction of natural grazing throughout the country, will largely be determined by the degree to which farmers' misconceptions in respect of pasture management can be eliminated and attitudes can be changed so that the desired state of affairs will prevail on every farm.

PLANT PRODUCTION PROMOTION

AGRONOMY RESEARCH

Summer grain

The total production of maize and grain sorghum has fluctuated dramatically during the past few years and this has had a far-reaching effect on the stability of South African farming. Viewed in the overall context, however, maize remains the most important grain crop, but grain sorghum has the potential to increase in importance in the future. The emphasis in research therefore falls directly and indirectly on obtaining greater stability at lower input costs.

Breeding

Maize - A morphological study of a number of breeding lines, to determine what characteristics can be associated with drought tolerance, indicated that tolerant types showed clear differences in cuticle composition and thickness and that the wax layers on the leaves varied.

Preliminary results in co-operative yield trials indicate that numerous new and better yellow and white commercial hybrids are being released, examples being the white hybrids SNK 2667, CG 4509 and TX 555 and yellow hybrids TX 564, PNR 6334, SNK 2334, PNR 6514 and CAR 564. However, known good performers such as PNR 6528, CG 4410, TX24 and HL2 have maintained very good and competitive yields in many trials.

A feature of many of the new commercial hybrids, mainly yellow, is that despite high yields, the quality of the grain is relatively poor. An additional characteristic is a higher incidence of ear diseases. This is ascribed to the use of increasing amounts of US Corn Belt breeding material by breeders.

New elite populations including both local and Corn Belt maize germ plasm featured prominently in last season's yield trials. These agronomically highly acceptable populations, known as MRS, MLS, FRS and FLS, have in some hybrid combinations outyielded high-yielding commercial control hybrids by 5 to 16%, indicating considerable potential for further improvement. This and other elite breeding material will be released this year.

A highlight of this year's work is the outstanding agronomic performance and grain characteristics of new improved yellow opaque-2 (High lysine) breeding material and experimental hybrids of the HL2 type. In two separate sets of trials at Ukulinga and Cedara, numerous hybrids of the M x F heterotic type outyielded the controls SNK 2244 and HL 2 by an average of 5,8 and 13,5%, respectively.

Grain sorghum - More than a thousand F_2 populations were developed from line crossings, crossings on populations and crossings where cytoplasmic-genetic male sterility was used.

Cultivar evaluation

Maize - One standard cultivar and 48 commercially viable cultivar entries were tested at 56 localities throughout the country for adaptability under low to high production potential conditions.

At the quality laboratory all new white maize cultivars that are submitted for registration are tested for trituration.

Grain sorghum - Eight standard cultivars and 41 other cultivars were investigated at 33 localities for characteristics such as yield capacity, standing ability and ear exertion. The quality laboratory does malting tests on all 49 cultivars at four localities so as to be able to place the cultivars on the grading system in a specific class. This is routine work which was taken over from the CSIR.

Plant pathology

Maize - A number of inbred lines with resistance to *Diplodia maydis* (50), boil smut (21) and head smut (37) were developed to the S5 selection level and can be tested for general combining ability. Genotypes which develop specific boil smut symptoms were also identified and can be used as standards.

An inoculation technique which correlates better with the natural boil smut infection process was developed. The occurrence of boil smut is further increased when the previous season's crop residues are left on the lands, since inoculation in the above-ground crop residues increases and is more freely available.

Protection of maize plants against infection by *Fusarium graminearum* by inoculating seedlings beforehand with certain isolates of *F. moniliforme* was generally found in various cultivars.

Grain sorghum - Sorghum germ plasma was developed in which resistance against and susceptibility to stem and root rot was identified and this is useful for further development of the gene pool. There was also found to be a difference between resistant and susceptible plants with regard to the number of lignified cell layers of the root.

Entomology

The maize stalk borer - At present the development of a mass breeding system for *Busseola fusca* takes high priority. A technique was developed whereby moths lay their eggs on an artificial substratum. Good progress was made in finding a suitable feeding medium for the larvae. Egg hatching is synchronised by making use of a combination of constant temperatures. This has the advantage that

insect production can be better co-ordinated with the desired growth stage of the plant.

False wire worm - The insect overwinters in the ground during the larval stage and consequently this damaging stage is already present at planting time in maize lands. The larvae pupate only during January and consequently soil cultivation is ruled out as a control measure. A key for the identification of the six damaging species was compiled.

Sorghum stalk borers - A record of the incidence of pests showed that sorghum stalk borers that were initially found only in the warmer parts of South Africa at present occur generally in the western part of the maize producing area.

Nematology - Although slight yield increases were obtained by the administration of a nematocide, it is still not clear whether these yield increases can be attributed mainly to the eradication of nematodes. However, the supposition has been strengthened that the chemical control of nematodes in maize may have serious negative economic implications.

In population studies on nematodes in maize and grain sorghum it was noticeable that *Pratylenchus* spp. were the most dominant group in terms of incidence on both crops and at all the localities involved. This study continues.

Plant nutrition

A combined laboratory-glasshouse study of the nitrogen production capability and the transference of administered nitrogen from one season to the next of various soils from the dominant maize cultivating regions was undertaken. Good progress has so far been made with soil analysis techniques with regard to various N fractions in the soil.

The influence of various nitrate:ammonium ratios in various nitrogen concentrations on the development of 10 inbred lines and 5 hybrids was researched in a series of glasshouse tests. A special water culture technique was developed for the purpose. It can be proved beyond all doubt that a small quantity of ammonium plays a very important role in the effective utilisation of nitrogen. Furthermore it was conclusively proved that genetic variations exist in this regard.

Five combinations of fertiliser application were researched at Viljoenskroon. A yield improvement of 11% was obtained with a vertical band as against a normal band application or broadcast fertiliser.

Weed control research

Various successful systems for specific weed problems have already been developed and these are arousing wide interest among the producers and in the chemical weed control industry.

Results show that the presence of mulch material does indeed negatively influence the effectiveness of weed-killers. This is mainly attributed to the intercepting action of mulch material. Various types of mulch are being further investigated, but do not appear to have such a great influence on weed-killer effectiveness.

Soil and climate effects - As a result of research into the appearance of atroscine phytotoxicity in normally resistant maize plants it was found that any inhibiting condition can lead to an increase in sensitivity to atroscine. Variations in sensitivity were found in various inbred maize lines. Numerous factors such as seed size, nutrition, environment and overdosing were identified as possible causative factors in the incidence of atroscine phytotoxicity.

Cultivar tolerance - A technique was developed for determining tolerance to five atroscines, the genetic tolerance of inbred lines to atroscine and the pattern of heredity were determined, and commercial maize cultivars were tested for atroscine tolerance. No commercial cultivar showed excessively low tolerance to atroscine.

Soil cultivation

At Cedara it was found that on soil on which no cultivation took place the crop residue covering was 83%. On soil that was cultivated with a chisel plough, the covering was 21%, as against 15% in the case of chisel and disk plough cultivation, and only 4% in the case of cultivation with the conventional plough. Soil temperatures progressively increased with a decrease in crop residues. The water content available to plants in the upper 600 mm of soil was significantly more for the no-till plots - an average of 13, 19 and 27%, respectively, higher than on plots cultivated with the chisel plough, chisel and disk plough and the conventional plough. With no till the highest yield of 7,6 t/ha was obtained.

Tests also showed that the angled tine plough is ideal for solving certain compaction problems.

The existence and importance of ground water levels in heterogenous sandy soil in the North Western Free State was intensively researched. During active growth of maize plants, an average fall in the depth of the water level of 6,7 mm per day was observed. A capillary rise of approximately 700 mm was observed in sandy monoliths.

Compacted layers caused by soil cultivation impeded the vertical movement of water. The vertical movement of water was also influenced by the clay content of the subsoil. It would appear that high clay contents in the subsoil result in the accumulation of water.

Yield potential

The soil water retention characteristics of all the most common soils of South Africa were determined. The available soil water contents, infiltration rates and suitability grades of various soils were tested. These were grouped according to soil forms and clay content. Laboratory and field techniques for determining available soil water are tedious and time consuming. The method of estimation from soil textural properties and organic

matter content will therefore greatly facilitate field applications and modelling.

The effective rooting depth of non-water stressed maize on a Metz series soil was found to be 750 mm. Under water-stress conditions the effective rooting depth was found to be 600 mm.

Potassium was found to increase the water use efficiency, especially under water-stress conditions.

Yield physiology

Since lodging losses are large in the high-yielding maize growing areas in South Africa the possibility of using foliar applied ethephon to improve standability was investigated at Cedara. It was found that ethephon markedly reduced lodging, with moderate reductions in grain yield, provided it was applied at or near tassel initiation at rates of 0,5 or 0,75 kg/ha of active ingredient. Earlier applications had little effect on lodging and later applications, near ear initiation, markedly depressed grain yield. Correct timing was therefore cricital to success.

Ethephon produced three necessary characteristics of lodging-resistant plants, viz. a low centre of gravity, strong stems and improved stem supporting strength at ground level.

Small grain

Breeding

Two A cultivars were released from the winter and intermediate wheat breeding programmes, namely Molen for the Western Free State and Tugela for the Eastern Free State. The two dryland spring wheat cultivars, Palmiet and Gamtoos, which were recently released, are being cultivated with great success by the producers of the Western Cape. One A cultivar was provisionally released from the irrigation wheat breeding programme. Biotechnological techniques are employed in support of the wheat breeding programmes. The cultivar Rama was released from the durum breeding programme for cultivation along the Orange River.

Cultivar adaptation

It was possible to make recommendations for the winter, summer and irrigation field cropping areas on the basis of country-wide adaptation trials and to limit the number of wheat cultivars recommended for planting to 14, 8 and 7, respectively. The task of the agricultural adviser and extension officer and the producer who has to make the choice is greatly facilitated by this.

An evaluation of existing cultivars and promising lines for tolerance of aluminium (Al) showed that there is better tolerance in the spring material. On the other hand, it appears that the winter and intermediate material in general has limited tolerance of high concentrations of aluminium in the soil. The new wheat cultivar Tugela that was released in 1986 in the Eastern Free State shows, however, a good tolerance of aluminium. This is a very positive characteristic which definitely promotes the capacity for adaptation of the cultivar. Efforts are being made to breed greater aluminium tolerance into wheat cultivars.

Over the past 10 years the wheat yield in the Winter Rainfall Region fluctuated each season, but nevertheless displayed a rising trend, with the result that the yield per ha in the Swartland and Rûens in 1984 was 25% higher than in 1974. The two new cultivars, Palmiet and Gamtoos, will make a further contribution.

The barley and oats cultivar evaluation programmes of the Small Grain Centre are making very good progress and specific recommendations can now be made for each area.

Soil cultivation and weed control

Cultivation methods such as ploughing, shallow cultivation with tined instruments and no till are being evaluated in combination with mechanical and chemical weed control. In the no till treatments a very poor stand was obtained as a result of the poor contact between seed and soil. In the other cultivations the seed bed was finer and wetter and it ensured a better stand. The no till plots gave the lowest yield.

Trials at Glen show that longer fallow periods preceding the sowing of wheat result in significantly higher grain yields than a short fallow system. This trend applied to the wheat crops of 1983, 1984 and 1985. With a short fallow system the use of a mouldboard plough after harvesting followed by shallow cultivation with a tined implement gives the best results. The use of a chisel plough combined with chemical weed control produced good results as regards water storing and yield.

The development of the oat panicle was described, a growth point development scheme for oats was set up and the tolerant growth point development stages for the application of hormone-type weed-killers was identified. It is now possible to apply hormone-type weed-killers to wheat, oats and barley according to growth point development.

Plant nutrition

The division of nitrogen fertiliser into applications at various growth stages was researched at Loskop, Sandvet and Vaalharts. No yield increase was noticed at any of the localities with the division of the nitrogen fertilisers. This confirms the premise that the total nitrogen application under irrigation conditions can be given at planting time, especially in cases where planting is done on a wet soil profile.

As far as the quantity of nitrogen is concerned no increase was effected at Vaalharts with an increased nitrogen application, while levels of above

130 kg N/ha at Sandvet produced no yield reaction. At Loskop a yield increase was achieved with the application of 250 kg N/ha. This result is in conflict with results obtained in the past at Loskop and will be followed up.

Plant pathology

During the past year foot rot (*Gaeumannomyces*) was observed in most of the irrigation areas and also the Koeberg area of the Swartland, the Rûens and the southern coastal plains of the Cape. In the Eastern Free State this disease is a problem particularly with wheat cultivated in light sandy soils in monoculture.

Crown rot (*Fusarium*) is primarily a dry-land problem and occurs in warm regions, especially in the central and western parts of the Free State, in the Swartland and in the Humansdorp and Paterson area in the Eastern Cape.

In the *Free State Region* it was found that a long fallow system limited the disease, probably because this system results in more stored ground water. Under these circumstances the plants are not subjected to such serious moisture stress and disease infections, if there are any, spread very slowly.

The incidence of eye-spot (*Pseudocercosporella*) is limited to a few areas in the Western Cape, while crater disease (*Rhizoctonia*) only occurs on the Springbok Flats in dry-land wheat. It was ascertained that if the infiltration of water into the heavy soils of the Springbok Flats during the Summer can be improved, as for example with the basin method of cultivation, it is to a large extent possible to control crater disease. As far as root rot in wheat is concerned, it was established that the best precautionary measures against this disease are to plant seed in well-drained soil and to ensure that germination occurs at the optimum growth temperature. The disease can also be controlled by the use of specific seed treatment preparations.

The identity of *stem rust* races and their frequency of incidence in South Africa was determined. The findings that during the past two to three years various new races of stem rust have developed, that one of these races is rapidly increasing, and that an important resistance gene such as SR24 in a popular cultivar such as SST44 at present offers no resistance against this race have emphasised afresh the importance of research in this area. Only one gene, namly SR31, at present still offers, in some cultivars, resistance to all prevalent stem rust races in the country.

In the evaluation of wheat germ plasma for resistance to wheat leaf rust biotypes good sources of resistance were identified only in material from the international nursery.

During 1985 airborne diseases of wheat in the *Winter Rainfall* Region were chemically combated for the first time. No preparations were previously registered for this purpose. This practice will henceforth probably be used more intensively. It was proved that the costs of spraying are more or less on a par with the price of 200 kg of wheat per ha. It is still cheaper to sow cultivars that are stem rust resistant than to apply chemical control.

Crop manipulation

Research in the Winter Rainfall Region has shown that the practice of giving seeding density in kilograms of seed per ha and that a system of plant stand per square metre should be adopted. A formula was devised that can be used to calculate the correct optimum plant stand for a given farming area.

Pest control

In a field trial in which the relationship between wheat yields and infestations of the Russian wheat aphid (*Diuraphis noxia*) in the 31st growth stage was researched, it was found that spraying with insecticide preparations is economically justifiable when 5 to 7% of the plants are infested. This confirms earlier findings on critical infestation levels and growth stages for the economic and effective control of the Russian wheat aphid.

In ecological studies done on the Russian wheat aphid, it was established that the aphid aestivates on self-sown wheat and Bromus grass. Most of the aphids appear on the most recent leaf, the second oldest leaf contains fewer aphids and the third oldest still fewer. The largest increase in aphid numbers occurs just before the development of the flag leaf. Late plantings are subject to a quicker increase in aphid numbers than early plantings.

In field trials it was found that the use of soil treatment preparations such as disulphoton at an early stage of the wheat plant provides outstanding control of the Russian wheat aphid. However, infestations increase slowly, to such an extent that the economic threshold values of 5 to 7% are exceeded in the 31st growth stage. At the critical stage corrective spraying was more effective and consequently also more economical than preventative treatments with soil systemic agents.

Research in the *Winter Rainfall Region* proved that damage caused by aphids can result in grain yield losses of 37% in oats, 38% in wheat and 39% in barley in a season such as that of 1985. A total of six aphid species occur in small grains in the Winter Rainfall Region and together they are responsible for these losses. Almost double the number of aphids per plant is necessary to cause a 38% grain loss in wheat than is necessary to cause a 39% loss in barley.

According to findings at Glen in the *Free State Region*, it appears that the presence of large quantities of diapause eggs, together with the quantity and distribution of rainfall, is primarily responsible for the large increase in the population density of the brown wheat mite. It would appear that a much lower infestation level than the existing norm of 30 mites per plant results in a noticeable effect on dry-land wheat production.

Birds do damage to grain lands situated near

rivers. Results of research in the *Winter Rainfall* Region show that numbers of the red bishop bird, in particular, can be reduced by catching the birds in mist nests. This is only successful under specific circumstances and the method therefore cannot be generally recommended.

Growth regulators

The influence of the use of seaweed products on wheat and barley in the *Winter Rainfall Region* was researched. No statistically indicative yield increase was obtained, but no detrimental effect was observed either.

Oilseeds and protein seeds

Groundnuts

Breeding - The development of cultivars with resistance to pod rot takes high priority. Two cultivars, namely Harts and Norden, display considerably more resistance to pod rot than the cultivar Sellie. In addition, breeding lines are now available which combine the quality characteristics of Sellie with resistance to pod rot.

Dry beans

Breeding - According to observation there are strong genetic variations with regard to the ability to produce under poor soil conditions. In the field of biotechnology the research of the past year dealt with the *in vitro* production of disease-free dry beans. Success has already been achieved on a small scale by making stem growth-point cultures. These cultures are then stimulated by means of hormones to form roots. Research is at present aimed at changing the method and medium constitution in such a way that the project may be economically applied in practice.

Plant nutrition - The results of nitrogen fertiliser tests show that there was no yield increase with N fertiliser under relatively dry conditions on fertile high-potential soils. On sandy soils a yield increase was obtained with an application of up to 60 kg N/ha. Side fertilising had no influence on yield.

Sunflowers

Breeding - Approximately 80 new breeding lines were identified with hybrid progeny which compare favourably with existing commercial cultivars. This material is also available to private firms for further use and evaluation.

Plant nutrition - Important information was obtained from fertiliser trials which shows that the fertiliser requirements for sunflowers were often overestimated in the past. The fertilising of sunflowers is often uneconomical, especially in the Western Transvaal and Western Free State.

Soil cultivation - Basin tillage trials on soils with a low infiltration rate once again showed that this new approach has considerable potential in the low rainfall regions. The past year was very dry with a lower than usual runoff, but basin tillage nevertheless pushed up sunflower yields by about 30% above the yields obtained with conventional cultivation methods. Basin tillage ought to be started at the beginning of spring and then maintained throughout the entire growth cycle so that moisture retention is utilised to the full. This method of cultivation will be more effective under low rainfall conditions at a high intensity on soils with a low infiltration rate, especially if the soil is reasonably deep and situated on slopes.

Soya beans

Breeding - The local source of variation is still being extended by co-operation of the international level with INTSOY (USA) and with AVRDC (Republic of China). Valuable material was obtained from these sources; some were evaluated directly in the yield trials, while others were used as parents in the breeding programme.

The results of the soya bean trials were also used to design a new system of cultivar grouping that can be successfully applied in South Africa.

Plant nutrition - A phosphor fertiliser trial with soya beans on a Bainsvlei soil form showed that the plants grow and develop progressively faster in proportion to the phosphor status of the soil. The nitrogen and phosphor content of the seed was also significantly increased. An increase in the phosphor status of the soil to 40 mg/kg led to a significant increase in seed yield. A further increase in the phosphor status is not economical.

Lupins

For the first time since 1973, when white rust caused the narrow-leaved lupin to disappear from the grain lands in the Winter Rainfall Region, lupins are again forming a welcome part of the crop rotation programmes on some grain farms. The reason for this is the availability of new resistant cultivars of narrow-leaved lupins.

Other field crops

Tobacco

Breeding and selection

Flue-cured tobacco - The breeding line A4 from the crossing combination NC13 X TL33 was released on a limited scale. It is a light cultivar with a short internode and a round leaf. The breeding line OD86 has up to now continuously produced a higher than average percentage of marketable tobacco, it is resistant to black shank, mosaic and mildew, and

manufacturers have reacted favourably.

Burley tobacco - The crossing of Greenville 107 with CB17 and CB37 still produces outstanding results and two of the lines are to be included in phase 2 trials during the coming season.

Air-cured tobacco - The back-crossing programme for resistance to black shank, mildew and mosaic is progressing well and certain of the F2 lines will be tested during the coming season in the various cultivation regions.

Germ plasm bank - During the past season the description of established seed assets was continued. A number of morphological characteristics and pathogenic reactions were noted. These data are stored in a computer and can be recalled or modified with the help of simple procedures.

Nematode resistance - Nematode-resistant breeding lines are already being used in phase 2 trials of the programme for flue-cured tobacco. A start was made on transferring this nematode resistance to oriental tobacco as well.

Biotechnological laboratory - A new biotechnological laboratory was recently established. The research by means of molecular techniques will be focused particularly on determining resistance of tobacco cultivars against potato Y virus.

Diseases and pests

Bacterial wilt disease - This disease, caused by *Pseudomonas solanacearum*, was found in the Lowveld, Groblersdal and Brits tobacco regions. About 170 cultivars and breeding lines have already been evaluated for resistance in the glasshouse. Certain promising plants were selected for use in a breeding programme.

Black shank - Metalaxyl is broken down in the soil after repeated use. A new experimental preparation gave good control of black shank on lands where metalaxyl was no longer effective. It may be possible to use this preparation alternated with metalaxyl to delay the breaking down process.

Aphids - Carbofuran is a broad spectrum insecticide with a long after-effect which is applied to the soil once at planting. It appears from glasshouse trials with aphids, however, that the action of the preparation in a sandy loam soil with a pH of 8,1 disappeared completely two weeks after application. In soils with pH 5,5 the action remained.

Nematodes - Surveys showed that, with the exception of the genus *Meloidogyne*, other parasitic genera like *Tylenchus, Xiphinema, Pratylenchus, Helicotylenchus, Scutellonema, Tylenchorynchus, Criconemoides* and *Trichodora,* in that order, often also appear in tobacco lands. Their importance should not be underestimated. The effect of chemical control measures on the various nematode genera is at present being researched.

Crop cultivation

It is known that drought conditions have a detrimental effect on the texture (grain) of cured tobacco leaves and indications have now been found that a lack of potassium and boron further worsens the situation.

Quality

Curing of air-cured tobacco - The use of mist sprayers in curing sheds is not recommended. Controlled ventilation of the natural moisture in the shed is a more effective practice. The loose-leaf crop of air-cured tobacco gives fewer crop losses and a higher marketable yield and income than a whole-plant harvest.

Fermentation of air-cured tobacco - It is recommended that producers do not ferment tobacco on the farm, unless it is unmarketable as a result of a green colour.

Chemical composition - The influence of the drought on the chemical composition of flue-cured tobacco is still clearly observable in its high alkaloid and chlorine quality.

Cotton

Breeding

Private firms began with the evaluation of the new Departmental cultivars Nebo, Selati, Betsie and Lido. The availability of these new cultivars with their excellent characteristics represents a great improvement in the genetic cotton potential in South Africa. Short growing season cultivars are being bred for the Western Transvaal and other marginal areas.

The acquisition of a fibre testing system with a high capacity for fibre quality evaluations is also an important milestone in the breeding programme. Where previously only 80 fibre samples per day could be analysed, at present 400 samples per day are being analysed. This year 19 000 fibre samples were analysed. At present 12 new applications are being evaluated at 20 localities as potential new cultivars.

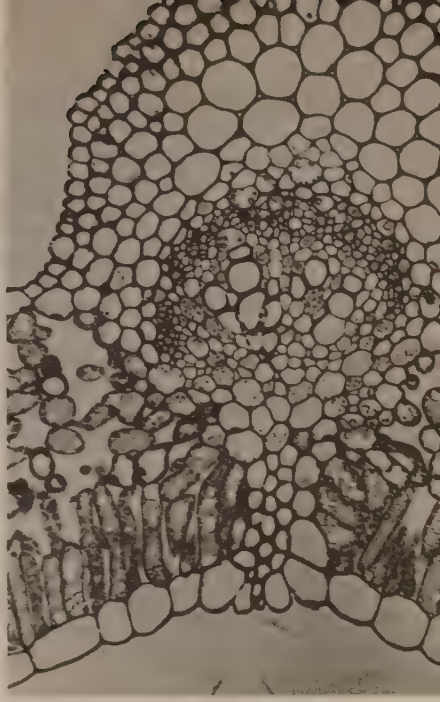
Diseases and pests

Bacterial diseases - Isolates from the bacterium *Xanthomonas malvacearum*, which causes diseases in cotton, were collected from various areas and race evaluation is being undertaken with a view to breeding for resistance.

Fungal diseases - Fungal diseases of cotton seedlings in various cotton areas were caused by *Rhizoctonia* species, and also to a lesser extent by *Pythium* and *Fusarium* species. Seed treatments are being tested.

Nematodes - The frequency of occurrence of parasitic nematode genera in cotton lands is, in declining order, as follows: *Pratylenchus, Xiphinema, Scutellonema, Meloidogyne, Trichodorus, Helicotylenchus* and *Aphelenchus*. All the genera occurred more frequently under irrigation. *Scutellonema*, however, was found more often under dry-land conditions.

Handing over new table grape cultivars to the industry. From left to right: Dr J. Deist (VORI), Dr D. Agenbach (Superintendent-General of the Department of Agriculture and Water Supply), Mr J. du Toit (Chairman of SAPO), Mr S. Hayward (former Minister of Agriculture and Water Supply), Mr T. Evans (VORI) and Mr P. Ellis (VORI)



Section of a vine leaf to study the anatomy

Cotton breeding focuses on the creation of new, improved cultivars for the industry

A seedling mango growth tip successfully established on a medium with activated carbon

Propagation material infested with root-knot nematodes can have a serious effect on the ginger harvest. This photo indicates the positions of nematodes in the rhizomes

Crop cultivation

During the recent dry seasons an increasing amount of cotton was cultivated under dry-land conditions because the profit was very favourable. Cotton that is cultivated in rotation with tobacco may, however, have a poor yield potential if a Ca deficiency is induced. This can happen in sandy soil types with low Ca levels if high K levels, as needed for tobacco, occur.

The yield potential of cotton under irrigation was increased by 25% during the past season by narrowing crop rows from 1,0 m to 0,6 m and by increasing the plant population from 50 000 to 125 000 plants per ha.

The growth-inhibiting substance mempikwat kept vegetative growth under control well where it was applied at a third of the recommended dose, but frequently and from the start of the flowering stage. It is of great importance especially during years with a more normal rainfall.

Chicory

Diseases and pests

Black root rot - In chicory this disease is primarily caused or aggravated by *Thielaviopsis basicola, Macrophomina phaseolina, Fusarium* and *Phoma.*

Nematodes - Although 13 parasitic nematode genera are found in chicory areas, the following genera appeared in high frequencies, namely *Meloidogyne, Pratylenchus, Tylenchus, Xiphinema, Rotylenchus, Scutellonema, Paratylenchus* and *Helicotylenchus.* Chemical control tests show that phenamiphos has greater possibilities than EDB.

HORTICULTURAL RESEARCH

Pomes

Apples

Pathology - *Scab* is the most important disease of apples. Excessive use of the new sterol-inhibiting fungicides has been found to give rise to less sensitive lines of scab fungus. This has important implications for the development of the future control strategy for scab. The judicious use of these highly effective fungicides is therefore of the greatest importance so that they can be used for scab control for as long as possible.

Physiology - In approximately 40% of the cases where new apple orchards are established on land on which apples were previously cultivated the trees grow extremely poorly as a result of specific *resettlement re-establishment diseases.* The problem can be prevented by fumigating the soil beforehand with methyl bromide, but the cost involved is R1 500 or more per hectare. To eliminate unnecessary fumigation, a biotest with which the presence of the disease can be forecast has been standardised and is ready to be used on a commercial scale. There are indications that it might be possible to control the problem biologically instead of chemically, which might reduce the cost considerably.

Ripeness studies have been done on apples and apple ripeness is already being monitored commercially to forecast optimum harvesting dates. The importance of this research for the industry could be seen clearly over the past season when abnormal weather conditions disturbed normal ripening patterns. Early in the year it was forecast that the fruit would ripen earlier than usual and producers were able to adjust their harvesting practices in time.

Pests - *Coddling moth* is the most important pest of apples and pears. It can cause a 90% crop loss under unsprayed conditions.

Past studies showed that it has two to three generations per season, but during the 1985/86 season a fourth generation was documented in South Africa for the first time. The development of a fourth generation demonstrates the ability of coddling moth to increase its infestation potential under favourable conditions.

Chemical control of *red spider* on apples can account for 30% of the pest and spray programme costs. It is therefore imperative to apply sprays against the mite only when and where necessary.

A unique sampling system for regularly monitoring red spider population levels in apple orchards has now been developed. Where it is implemented, an appreciable reduction in the number of miticide sprays and in the costs of control can be achieved.

Technology - The use of controlled atmosphere storage introduced a new era in the pome industry and research is still aimed at evaluating new techniques. The quality of Starking and Golden Delicious apples remains better than in the past if the gas concentrations are reduced to 1,5% carbon dioxide and 1,5% oxygen. A further important finding was that carbon dioxide does not damage Granny Smith apples as quickly as was initially thought. Carbon dioxide can therefore be present in the cooling room for short periods without any negative effect on the fruit.

Breeding - In die breeding programme for compactness McIntosh Wijck was used as donor parent. Approximately 2 000 seedlings were developed from McIntosh Wijck progeny by means of open pollination and crossings on standard cultivars as receiving parents. Four selections with a red colour, the desired degree of compactness and acceptable fruit quality were identified.

Crop science - A number of legumes, namely clover, subterranean clover and vetch, look promising as *cover crops* in apple orchards. The subterranean clovers in particular grew well, reproduced efficiently, did not compete with the tree for pollination by bees and died in the summer so that there should not be competition for water and nutrients during the tree's active growth period.

Pears

Physiology - The poor keeping quality and short shelf life of Bon Chrétien pears results in large losses for both canners and exporters. Trials have shown that the fruit's keeping quality can be considerably improved by treating it with a waxing agent before storage.

Good progress is also being made with the method of forecasting the keeping quality of fruit from different areas on the basis of climatic data and fruit analyses.

Technology - Research has led to it becoming possible to store Bon Chrétien pears successfully in a controlled atmosphere for 12 weeks in contrast to a normal maximum storage period of 8 weeks. This is extremely significant from a marketing point of view.

Breeding - Four selections were identified from the breeding programme for scab-resistant pear cultivars that were promoted to Phase II evaluation and planted out in four different localities. These selections were obtained from crossings between Kieffer and Bon Rouge cultivars. Four further selections were obtained as promising breeding material that could replace the Kieffer cultivar. It is expected that these selections will produce fewer stone cells in the progeny than the Kieffer cultivar.

Drupes

Plums

Pathology - Bacterial canker is a destructive disease of plums and other drupes. It can kill whole orchards within one to three years of planting. Different lines of the causative pathogen were found to have an equal degree of malignancy for drupes and pomes (bacterial leaf spot in apples; bacterial blossom blast in pears).

Physiology - The incidence of internal breakdown in Santa Rosa, Harry Pickstone and Songold plums was considerably lower during the past season than during the one before that.

Provisional observations have shown that the total concentrations of calcium, potassium and magnesium in the leaves can explain 61% of the incidence of internal breakdown. A better correlation is expected using fruit analyses. No clear differences or trends could be found in the other macro or micro-element concentration in leaves from the three cultivars, which came from the Stellenbosch and Grabouw areas.

Peaches

Pathology - The 1985/86 season was characterised by fruit that ripened faster than during previous years. As a result the fruit, especially nectarines, bruised easily when harvested and handled. This gave rise to *post-harvest rotting*, caused by *Mucor piriformis*. This type of rotting had not previously been found in drupes on a large scale and required fast action. Control measures developed for pomes were used successfully.

Physiology - A new line of research was followed during the past season in respect of the elimination of *woolliness* in sea exports of peaches and nectarines. Nectarines were ripened at different temperatures varying between 10 °C and 20 °C after a cold-storage period of four weeks at 5 °C and were then examined for woolliness. At ripening temperatures of 15 °C and higher woolliness was completely eliminated. The same promising results were obtained by ripening the nectarines at 20 °C for two days only and then returning them to 10 °C for the rest of the ripening period.

Other horticultural crops

Rooibos tea

Pathology - Early dying disease of rooibos tea not only places a serious restriction on the expansion of this industry, but also threatens its continued existence. The causative disease pathogen has now been identified.

Nutrition - In pot trials it was shown that rooibos tea seedlings grow best with 15 to 20 mg of P and 60 mg of K per kg of soil. Different sources of phosphate and potassium did not differ significantly. With high levels of phosphate fertilisation, however, the growth of seedlings is drastically suppressed. Rooibos tea has a low lime requirement, but nonetheless reacted favourably to small applications of lime. It also appeared that, although sufficient nitrogen is fixed by *Rhizobium* spp. to provide for the plant's needs, small applications of nitrogen on planting help establish the seedlings better.

Olives

Nutrition - The intake of foliar-applied nutrients by olives took place only through abaxial surfaces. Different wetting agents that were tested had a significant effect on the uptake of nutrients by the leaves.

Kiwifruit

Crop science - The influence of winter temperatures on the fertility of shoots of two kiwifruit clones, namely Hayward and Allison, was investigated in three climatic areas in Natal. The initiation of flowers in both cultivars took place a few days before the swelling of buds. The development of shoots had such a negative effect on the initiation of flowers that only flowers that developed within a week of the initial flowering date were fertile. The great need for cold of the Hayward cultivar was a serious disadvantage in this regard, since it gave rise to an extended flowering period and therefore resulted in poor fruiting. An investigation into more effective dormancy-breaking for the Hayward cultivar will therefore be essential if

this cultivar is to be grown successfully in regions with insufficient winter cold.

Viticulture and Oenology

Wine grapes

Anatomy - Seven cultivars were examined using the light microscope to determine their qualitative *leaf characteristics* in the middle of the growing season in three shoot positions, namely apical, middle and basal. The examination gives a clear picture of what the tissues and cell contents of healthy leaves look like and how the leaf structure changes with age. Anatomical abnormalities based on qualitative characteristics can therefore be easily identified in future and the results of this research are already being used in other research. It will also be very useful when plant samples from the industry have to be examined for some problem or other.

Physiology - The effect of *topping* on the vegetative and reproductive growth and on the chemical composition and concentration of sugars, organic acids and mineral elements in berries of Cape Riesling was investigated. It was found that judicious topping has beneficial effects on berry composition and it is recommended in vigorously growing vineyards.

Nutrition - Pot trials carried out to determine the best form and time for applying *N fertilisers* showed that the grapevine's N requirement during the period from budding to the end of blossoming is 25% higher than the ability of the roots to absorb it. An adequate pool of reserve N during this period is therefore essential. Autumn fertilisation plays an important role in this regard and almost 70% of the N taken up in the autumn is still available as reserves at the start of the following season. In the case of N taken up in the spring, less than a quarter is still available as reserves at the start of the following season. During the post-harvest period a migration of N also takes place from the leaves and shoots to the permanent structures of the vine. Approximately 20% of the reserve N present in the vine at the time of budding comes from these sources.

Cultivar evaluation - A large number of *red wine grape cultivars* was evaluated over a period of almost 10 years in the Darling region. Results of this trial show that Tinta Barocca, Pinotage and Cinsaut performed the best if yield and quality of wine together are used as the criterion. With quality of wine as the only criterion, Cabernet Sauvignon produced the best results. These cultivars are recommended within the limits of supply and demand for the area.

In respect of *rootstock cultivars* the results of a trial in the Montagu region indicate that 99 Richter, 101-14 MGT, Metallica and Dog Ridge are well adapted in those circumstances. The results show clearly that large clonal differences can be found within the same cultivar in respect of growth and crop. This means that rootstock cultivar recomendations cannot be made without the clone being considered.

Pathology - *Crown gall* (caused by the soil-borne bacterium *Agrobacterium tumefaciens*) is an increasing problem in the warmer areas, in particular. No effective control measure has yet been found against this disease. The susceptibility of *rootstock cultivars* was determined against five races of the bacterium in a field trial. Results showed that Paulsen 775 is the only rootstock that is completely resistant to all five races. The others' resistance varies from moderate to susceptible.

On the basis of these results, recommendations could for the first time be made to the South African producer in respect of rootstocks that are resistant to crown gall. The findings are also of importance for other countries, since this was the most comprehensive investigation of its sort anywhere in the world.

Crop science - The results of an *eye load trial* with Red Muscadel on different rootstocks with winter pruning show clearly that pruning recommendations will in future definitely also have to take the rootstock cultivar into consideration. In this trial different eye loads always gave the best results on 110 Richter and Ramsey, while Rupestris du Lot performed poorly. It is clear that an eye load of between 24 and 32 eyes per vine gives the best quantitative and qualitative results if 110 Richter and Ramsey are used as rootstocks. It is also clear that eye loads of more than 32 eyes per vine have a serious negative effect on the colour of Red Muscadel wine.

Water requirements - In an irrigation trial at Robertson there was a significant decrease in production with a 25% ground-water level in comparison with water levels of 70% and 90%. The results indicated clearly that crop yield is not affected by a reduction in the ground-water level from 80% to 70%; in fact, even with a 50% ground-water level the yield was only slightly lower. The driest plots and the drip plots produced the highest sugar concentrations. Regular irrigation increased the total titratable acids and mallic acid was influenced more than tartaric acid. The *irrigation system* did not make any difference in respect of vineyard performance, but between 25% and 30% of water was saved using drips rather than microsprays, sprinklers and flood irrigation.

A high *irrigation frequency* of a period of irrigation every two days had to be applied with drips to maintain a ground-water level of 90%. A much smaller root system also developed under drips in comparison with microsprays, for example. Crop factors increased from 0,3 in October to 0,49 in January.

Table grapes

Breeding - An effort is being made with the *table grape* breeding programme to fill gaps in the present marketing spectrum and to expand or improve the cultivar spectrum, since almost all the existing cultivars have some physiological or storage problem. The successful breeding of a new cultivar is

a process that takes between eight and twelve years and the chances for a successful seedling are only about one in 10 000. During the year under review six *new table grape cultivars* were released that will have a great impact on the industry in the future. These are the following:

Pearl - A straw-coloured grape with a delicate muscat flavour that ripens approximately three weeks earlier than the earliest cultivar grown commercially in South Africa.

Muscat Seedless - A white muscat-flavoured seedless grape that ripens approximately three weeks before Sultanina. Muscat Seedless stores well and an important characteristic of the cultivar is that the muscat flavour is retained after storage.

Rubistar - An early dark red cultivar that ripens at approximately the same time as Queen of the Vineyard. The berries are of a very attractive medium size and slightly muscat-flavoured.

La Rochelle - An early black grape that ripens at approximately the same time as Dan-ben-Hannah. The cultivar has large berries, colours easily and has a very good eating quality. La Rochelle has a better keeping quality under cold storage than any existing export cultivar.

Bonnoir - A black, early mid-season cultivar that ripens just before Alphonse Lavallée. Bunch preparation requires little labour and the cultivar is also considerably less prone to berry cracking than Alphonse Lavallée. Bonnoir also has a better keeping quality during cold-storage than both Dan-ben-Hannah and Alphonse Lavallée.

Belair - A mid-season to late-season black grape that fills the important marketing gap between Alphonse Lavallée and Barlinka. Belair has good quality and storage characteristics, colours better than Barlinka and has an eating quality that is equivalent to that of Alphonse Lavallée.

Pests - *Bud mite disease* and *bud mite* are two well-known vineyard pests that must be chemically controlled each year. Both are races of the mite species *Eriophyes vitis*. It was proved recently that a third biological race of *E. vitis* is found in South African vineyards. This mite is known as the leaf-curl mite. The pest is being found increasingly on wine grapes and must be controlled in young vineyards, in particular.

Lesion nematodes (Pratylenchus spp.) is a pest that attacks vineyard roots and can cause serious losses. The eelworms are of particularly great economic importance for the nursery industry, since infested vines cannot be sold. No control measures are available for cleaning already infested plant material and producers were obliged to destroy such material.

Trials have now shown that a 1% fenamiphos solution kills the nematodes inside the roots. The method is simple and relatively cheap. It is just as effective as hot water treatment and no negative side effects have been observed. The method could protect the *nursery industry* against thousands of rands of damage per year.

Crop science - Visual examinations of the size and colour of grape berries are often made to assess and determine the correct *harvesting* time. However, these criteria can be misleading as they depend largely on climatic conditions and viticultural practices. A study was undertaken to determine the optimum maturity stage of Waltham Cross, Bellevue and Dauphine. It was found that Waltham Cross and Dauphine can be harvested from 16 ° Balling to 18 ° Balling without loss in eating and *keeping quality*. Owing to a more rapid drop in acidity, Bellevue reached acceptable overall quality at 14,5 °B.

Keeping quality was not noticeably affected by picking stage and there were even indications that Waltham Cross picked at a later stage was less prone to loose berries.

Wine

Technology - The effect of rehydration temperatures on the rate of fermentation and the viability of 13 *Saccharomyces cerevisiae* dried wine yeasts was investigated. In general the optimum rehydration temperature for viability is higher than the optimum temperature for rate of fermentation. Yeast strains also differ among themselves in respect of optimum rehydration temperatures. It is recommended that rehydration take place at between 35 °C and 39 °C. These temperatures are lower than the 40 °C and 43 °C recommended in the past.

The use of the yeast cell walls to restrict *retarded fermentation* was investigated. According to overseas researchers the cell walls can prevent retarded fermentation in that they absorb octanoic acid and decanoic acid, which are toxic for the yeast, from must.

Trials were done in which the yeast cell wall preparation was added to fermenting must and it was found that fermentation was stimulated. This could therefore contribute to limiting or even eliminating retarded fermentation. The quality of the wines was, however, without exception poorer than that of control wines. The use of yeast cell walls to stimulate fermentation is therefore strongly deprecated.

The incidence of *"killer" factor* in wine yeasts of the culture collection of the VORI was investigated. From a total of 96 yeast races investigated, 85 were *Saccharomyces cerevisiae* races. Of these 85 yeasts, seven races contained "killer" factor, nine races were neutral and 69 races were sensitive to the "killer" factor.

In fermentation experiments where "killer" and sensitive races were inoculated together it was shown that fermentation is in no way affected where the "killer" race was present at less than 2% of the inoculum. At higher concentrations the "killer" races sometimes took over and completed the fermentation.

It is deduced from the trials that the use of a specific yeast race should not depend on whether it is a "killer" race or sensitive to "killer" races. Important oenological criteria such as speed of fermentation, the formation of foam, wine quality, etc., should be the decisive parameters for selection. The "killer" status of a yeast race must, however, be

taken into consideration when it is used in practice.

The VORI participated in an international investigation that preceded the legalising of the use of *polyvinylpolypyrrolidone* (*PVPP*) during the preparation of wine. Local trials showed that PVPP cannot be used to remove all colour from poor red or rosé wine. It is therefore not possible to convert a poor red wine into a marketable white wine by using PVPP. Also, it was clear that although the brown colour of oxidised white wines can be much improved by PVPP, the resulting wine was still not an acceptable product. The use of PVPP in the preparation of wines was approved by the International Wine Office as an aid in making polyphenol adjustments in good quality wines.

The influence of *grape cultivar and yeast strain* on rate of fermentation was investigated. Rate of fermentation in musts from Chenin blanc, Colombar, Semillon, Muscat d'Alexandrie and Cape Riesling were strongly influenced by the presence of a specific turbidity factor. The musts of the above cultivars differed strongly in respect of filterability. While must filtration resulted in serious fermentation problems (retarded fermentation) in the first two cultivars, the rate of fermentation was not affected in the last two cultivars. Eight races of *Saccharomyces cerevisiae* were examined and seven of these races required the specific turbidity factor to complete fermentation.

It is therefore clear that must clarifying techniques must be adapted to the grape cultivar and yeast strain that are to be used.

Citrus and subtropical crops

Citrus

Physiology - In a search for resistance of citrus fruit to the serious *greening disease*, which is responsible for commercial production being stopped in certain areas, a callus line was selected with the aid of *in vitro* breeding that is tolerant of high concentrations of gentisic acid. Embryos are at present being treated so as to generate plants that will possibly have a high degree of tolerance of or resistance to greening.

Crop science - Two important candidates were identified for commercial planting, namely the Miho-Wase-satsuma mandarin and a new red grapefruit selection. The Miho-Wase, which aroused great interest among exporters, is already being recommended on a semi-commercial scale. The red grapefruit selection is at present being intensively studied with a view to release. The *Bahianinha navel* performed best in respect of production and fruit quality in the Eastern Cape.

At Addo the Van Staden roughskin lemon selection was identified on the basis of four years' data as a promising *rootstock* for Olinda-Valencia and the Palmer navel. This selection performed considerably better than the Cairn commercial selection and 70 other roughskin lemon rootstock selections.

The *fruit setting problem* in Clementine mandarins has finally been solved. Spraying with gibberellic acid during full bloom is now recommended as standard practice for this cultivar.

The first super plant tree cultivated in accordance with the guide-lines of the *Citrus Improvement Scheme* was donated to the CSFRI by the Zebediela Estate. 42 different citrus selections have now been made available to the citrus industry and it is expected that a further 15 selections will be made available to the industry in the near future.

Nutrition - Trials with citrus fruit in the Citrusdal area have shown that a low soil pH does not necessarily, as is normally thought, indicate a *need for lime*. Applying lime brings about a reaction only if there is a high level of extractable aluminium in the soil. Even with a pH of 5,0 no reaction is obtained with lime unless there is also a high level of aluminium.

Pests - Four insecticides were identified, tested and found suitable for the control of the Lowveld *citrus mite*.

A copper plate and spraying the trunk with copper sulphate prevents the *brown slug*, which causes serious damage to the fruit and leaves of citrus trees, from climbing up a citrus tree for months.

The *citrus psylla* is the vector of greening disease and any combination of citrus cultivars with lemons and to a lesser extent with navels will possibly be subject to higher psylla populations than areas with only one cultivar. Lemons and navels should not be planted near one another, but Valencias and grapefruit apparently combine well. Navel trees in Rustenburg, whether irrigated or cultivated under dry-land conditions, have new growth almost throughout the year and can clearly support psylla populations through the year.

Pathology - *Tristeza viral disease* is a serious threat to the citrus industry. Light lines of tristeza for cross-protection are now imported in all graft-wood released under the Citrus Super Plant Scheme.

Pineapples

Breeding - A number of very promising clones have been isolated and attain a canning quality that is above average.

Nutrition - In soil with a high level of aluminium and a low pH (3,7 to 4,2) pineapples grow far better where 10 tons of agricultural lime have been applied than in soil that has not received anything. The incidence of *Phytophthora*, which causes great losses in wet years, in particular, is also far lower where lime is applied in large quantities.

Pests - At the moment EDB fumigation is still the most promising for *eelworm control*.

Promising results have been obtained for *ant control* with a new agent. An endosulphan spray programme was compiled that has a significant suppressive effect on the incidence of *leathery pocket*

if it is applied at the right stage in the plant's development.

An entirely new type of insecticide formulation for the control of *soil beetles* is being evaluated in pineapples and may possibly replace dieldrin.

Pathology - In soil with a high clay content the threat of *Phytophthora* is very serious in wet seasons. During the past season with its high rainfall excellent control was obtained with two preparations over *root* and *heart* rot caused by *Phytophthora* species.

Bananas

Physiology - Somatic embryos were observed in callus cultures initiated from flowering tips of Dwarf Cavendish bananas. Efforts are being made to regenerate plants from them with the aim of finding mutations that may, for example, be resistant to the serious *Panama disease*, which has already broken out in two areas in South Africa.

Crop science - Until now it was found that a density of 2 222 plants/ha produced the largest plant harvest, but follow-up tests show that a lower density, namely 1 666 plants/ha, produces better in the long term in the Transvaal. In Natal the plants are smaller and the cycles shorter than at Burgers Hall and a plant density of 2 222 plants/ha after three cycles is far better than 1 666 plants. In Natal a density of 3 333 plants/ha is being investigated at present.

Water requirements - Trials in Levubu showed that the yield per annum of the first spray crop cycle can be improved by 51% by increasing the crop factor for *banana irrigation* from 0,25 to 0,75. Using the same amount of water, drip irrigation produces a far greater yield than both the sprinkler and microspray methods of irrigation.

Nutrition - It was shown in various fertilisation trials that bananas have a fairly low *nitrogen requirement*. An annual application of 90 kg to 110 kg N/ha is adequate. Optimum yields are obtained with an N content of 2,5% to 3,0% in the leaves.

Pests - It was found in an investigation that *root knot nematode* and false Panama wilt (vascular bundle discolouration) are one hundred per cent associated with one another.

Pathology - The geographical distribution of *Panama wilt* has now been fully determined. A cultivar recently imported from abroad shows promising resistance to this disease and is at present being tested in field trials.

Technology - Storage at 11 °C and in a controlled atmosphere of 1% oxygen and 7% carbon dioxide increases the shelf life of bananas by two to eight weeks.

Avocados

Pests - *Heart-shaped scale insects* cause serious problems in certain areas at present and reduce the percentage of exportable fruit. They produce large quantities of honeydew on leaves and fruit, which leads to the formation of sooty mould. With the help of research it was proved that various parasitic wasps and a tortoise beetle could keep the scale insects under control provided that dust was limited to a minimum and the balance between pest and parasite was not disturbed by injudicious spraying.

Technology - Physiological problems that develop during storage can be reduced if the avocados are stored in an environment with a high carbon dioxide concentration (20%) for three days directly after harvesting and then in a controlled atmosphere.

Mangoes

Physiology - Growing points were established with the aid of tissue culture, but many problems were experienced with contamination and browning. These were solved by individual sterilisation and the use of an anti-oxidant. Problems are still being experienced with bacterial contamination.

Breeding - The mango selection programme is progressing well and six selections are at present being described with a view to applying for provisional plant breeders' rights. A total of 17 of the most promising selections were supplied under contract to producers to be evaluated in different climatic regions in the Northern and Eastern Transvaal.

Pests - The best control of *fruit fly* was obtained by plunging the fruit into 48 °C water for 45 minutes.

Orchard surveys have shown that the serious *mango scale plague* is being held in check to a certain extent by a parasitic wasp, two tortoise beetles and a *Cecidomyiidae* larva.

Pathology - A campaign was begun to eliminate *flower malformation* in mangoes. It seems to have been extremely successful up to now, but another few years are needed to complete the campaign successfully.

Guavas

Breeding - From more than 1 000 seedlings, four selections are at present being described with a view to applying for provisional plant breeders' rights.

Granadillas

Rootstock selections - The red granadilla (*Passiflora caerulea*) was released during the past year for commercial planting as a rootstock for the ordinary purple granadilla. The advantage of this rootstock is that it is more resistant to *root diseases* than the purple or yellow granadilla.

Pecan nuts

Crop science - The way in which differentiation between male and female flowers

takes place in five pecan cultivars, namely Barton, Mahau, Moore, Ukulinga and Success, was determined over four consecutive seasons. Eight different stages of development could be distinguished for female flowers and five stages for male flowers. The grouping of cultivars according to the periods at which female flowers were receptive to pollen and pollen would germinate could be based on the length of the catkins of the different cultivars. The choice of pollinators when orchards are planted can be made more accurately through the use of this method.

Coffee

The instant coffee market's consumption is 85% of the total coffee consumption in the RSA and robusta coffee is used for this market. Research is being done to determine the potential yield of promising robusta plants.

Pepper

There is at present great interest as regards the local production of pepper. The processed pepper from trial plants was commercially evaluated and found to be acceptable in comparison with imported pepper. Planting material is available for prospective producers.

Ginger

Physiology - *Tissue culture* of *ginger* meristem culture was investigated as a method for the elimination of nematodes, which cause great losses in ginger. The most important agrotypes have already been declared nematode-free in the process of clonal multiplication. It will be of great value to the industry if sufficient nematode-free plants can be made available.

Pests - *Root knot nematodes* can be effectively controlled in ginger plantings by applying fenamiphos granules twice during the growing season. Treated plots have produced 31,5 t/ha of ginger, as against the 12,1 t/ha of untreated plots.

It was established that heavy infestations of nematodes can reduce the intake of potash by ginger plants.

It was also established that plunging infested seed rhizomes into fenamiphos solutions can contribute significantly to making nematode-free ginger seed rhizomes available.

Tuber crops

Potatoes

Breeding - The biggest *problems* in the potato industry are still the low production per unit of area, poor quality and poor keeping quality and the inefficient utilisation of soil moisture. The variable dryland production and the lack of genotypes with a tolerance of high temperatures and of diseases such as corky scab, fusarium and bacterial wilt can be regarded as the main reasons for these problems.

In relation to the identified problems, good progress is being made with the development of improved *genotypes* with a high dry mass, higher tolerance of temperature and moisture inhibition and considerably better internal quality. Progress has also been made with the development of acceptable genotypes in respect of tolerance of corky scab and fusarium. Application has been made for the release of three *breeding lines as cultivars*. Storage trials have confirmed the good keeping quality of these lines in comparison with Up-to-Date and BP1 under Highveld conditions. Applications for the introduction of a further five cultivars are being prepared.

Physiology - *Biotechnological techniques* in potato breeding are receiving high priority. Anther cultures for the production of dihaploid plants have been started and callus is already being produced. Single-cell cultures of the most important potato cultivars in the RSA have also already been established and efforts are being made to regenerate plants from single-cell cultures. Potato protoplasts are being successfully isolated and the cultivation and regeneration of plants from protoplasts is being undertaken at present. Good progress has been made with the development of techniques for the *in vitro* long-term storage (12 months and longer) of potato gene pools.

Pathology - *Virus elimination* as part of the plant improvement scheme for potatoes by means of meristem culture is carried out on a routine basis. An antiserum against an overseas isolate of *potato roll leaf virus* is being prepared locally. Further, a local isolate of the virus has been obtained by means of single-plant lice transfers and an antiserum against it can now be prepared.

The Department has withdrawn completely from the multiplication phases of *virus-tested seed potatoes*. The Sabie unit has been taken over by the Potato Board and at this unit, as well as at the Board's own farms in the Lydenburg district, seed potatoes are now being multiplied and allocated to seed potato producers throughout the country. The Department is, however, still keeping a few virus-free plants of the various cultivars and breeding lines in isolation at Roodeplaat as a source of *sound foundation material.*

Fusarium dry rot is one of the most important post-harvest diseases of potatoes. Results indicate that, in addition to *Fusarium solani*, a number of other *Fusarium* species can cause dry rot. A survey of the *Fusarium* species in the ground is being done with a view to formulating a control strategy in a specific region.

In a survey on *bacterial wilt* it was found that biotype 3 of the causative bacterium (*Pseudomonas solanacearum*) is responsible for all cases of wilt in tomatoes, while biotype 2 is involved mainly in potatoes. A further important finding is the fact that infected plants do not necessarily develop symptoms

at low temperatures and in this way the disease can be transferred unseen.

Vegetables

Tomatoes

Breeding - The tomato breeding programme is progressing well. The combination of good *fruit quality* and resistance to bacterial wilt, bacterial canker, kromnek virus and eelworm has been achieved in both table and canning tomatoes and good lines have been obtained that will be released shortly. The combination of quality and *resistance to disease* of these lines cannot be bettered anywhere in the world.

A reliable method for evaluating resistance to bacterial canker in field tests has been developed and will speed up breeding for resistance considerably. The first kromnek virus-resistant table tomato with resistance to *Fusarium* race 1 and *Verticillium* has been registered as Stevens. It is producing good yields in the Western Cape, the Eastern Cape and the Transvaal Middleveld.

Pests - An effective preparation for the control of the American *leaf miner*, which has become established in the Transvaal Lowveld and the Pongola region, has been registered.

Onions

Breeding - A medium day length onion with hard, dark brown bulbs has been registered under the name Roël and is recommended for the Western Cape. It showed a better yield, uniformity and keeping quality than Caledon Globe in a trial at Riviersonderend.

A new onion cultivar, Radium, bred for the Transvaal, has just been released. The cultivar has round bulbs and a good keeping quality and is ready for harvesting approximately two weeks after Pyramid.

Crop science - A spacing trial with Texas Grano at Roodeplaat confirmed that the best *spacing* is 200 to 250 mm between rows and 75 mm within rows. According to a study done on onion seedlings, *seed size* has a slight effect on yield, while *sowing density* in the seed bed has a significant effect. With a sowing density of 3 000 seeds per m^2 and 6 000 per m^2 there was a decrease in yield with the higher sowing density of 20,9% in Caledon Globe and 27,1% in Australian Brown.

Legumes

Green peas

Breeding - In the pea breeding programme at Roodeplaat particular attention was given to the development of lines that are semi-leafless and resistant to powdery mildew. Six lines that looked promising the year before were evaluated and two of these were found to be extremely promising.

Dry peas

Breeding - The overseas cultivar Miranda and the semi-leafless breeding line of the Institute that did well last year once again fared well this year under conditions in which frost is a limiting factor. The breeding line has just been released as a new cultivar with the name Ropi for planting in the Transvaal, in particular.

Green beans

Breeding - Seven breeding lines with speckled and white seeds with a high degree of resistance to halo blight and brown rust were further evaluated at Roodeplaat, Elsenburg and Glen. On the basis of these evaluations, four lines are being registered as new cultivars.

Brassicas

Cauliflower

Breeding - Two promising cauliflower lines have been bred. One line is just as early as Spring Snow and gives the same yield and better head quality. The other line is 15 to 20 days earlier and has a better head quality.

Broccoli

Crop science - A *sowing time trial* was done at Addo in the Eastern Cape. From the trial it was clear that Premium Crop gives the best results over a wide series of planting times, while Dandy Early can be sown in the optimum sowing time of the middle of January to the middle of March. Late Corona can be sown up to the middle of May.

Root crops

Carrots

Breeding - The selection programme with Cape Market and Chantenay Karoo was continued and good progress was made in respect of untimely seeders and type authenticity.

Water requirements - Water consumption under summer conditions was investigated and it was found that 88% of total water consumption is withdrawn from the top 450 mm of the soil.

Sweet potatoes

Breeding - Advanced lines from the breeding programme were evaluated in each of the cultivation areas and the best lines included four polycrosses at Nelspruit. From these lines it will be possible to breed new and better cultivars for the fresh market, rapid freezing, dehydration and starch production. The most promising lines are already doing as well

at this stage as the best cultivars.

Crop science - The investigation into optimal plant population for the fresh market was completed. A plant population of 33 000 plants per ha is recommended.

Pathology - The most important sweet potato virus was identified. It can be eliminated by heat treatment and meristem culture of the plant material.

Runner crops

Pumpkin

Breeding - Two new pumpkin cultivars, Roversberg and Rovaal, from the *Cucurbita moschata* group, or the so-called selons pumpkins, were placed on the variety list and released. Rovaal is exceptionally well suited to freezing and processing. The new cultivars did very well in the Transvaal Middleveld and the Southern Cape in evaluation trials. The flat white boer pumpkin did better in the Free State. The results of a programme for breeding a flat white boer-type pumpkin with a bushy growth habit instead of a vine look promising.

Spanspek

Breeding - The seed source of Green Elche was improved. This cultivar is very popular in the United Kingdom and Europe and is suitable for export by ship. A round yellow and cream spanspek breeding line did very well in evaluation trials and is being considered for release.

According to the results of a cultivar trial done at Elsenburg, Earli Sweet is extremely suitable for export and Early Dawn and Lyon Jumbo are suitable for local marketing.

Crop science - Research on weed-killers has led to the possibility of a grass-killer being registered for use on runner crops.

Flowers and ornamental plants

Flowering bulbs

Ornithogalum (Chinkerinchees): A total of seven cultivars have up to now been bred at Roodeplaat with white and yellow flowers and further breeding is aimed at producing a good orange-coloured cut flower.

Gladiolus: Various further crossings were made and five good selections are at present being multiplied by means of tissue culture. The emphasis in the breeding programme is at present falling fairly sharply on cytogenetic studies, since these are important in the specific breeding of a crop in which a number of species, varieties and cultivars are used. The breeding of cultivars with a pleasant fragrance and resistance to rust (*Uromyces transversalis*) is still receiving priority.

Lachenalia: During the year under review the focus was mainly on the evaluation of the large amount of *breeding material* and the identification of further breeding programmes. Of the 35 selected potential cultivars, 12 were released to the flower industry and are at present being multiplied.

All cultivars and selected potential cultivars were subjected to *virus cleansing* so as to provide virus-free bulbs to the industry. Although *tissue culture techniques* speed up bulb multiplication considerably, producing enough bulbs is still a slow process.

Crop science - Manipulation studies on the growth and flowering periods of *Lachenalia* show that 20 °C is the optimum temperature for flower initiation, since the plants develop more quickly.

It also produces longer inflorescences and larger flowers than the other treatments.

Other flowering bulbs - In view of the great potential of this group of plants, the Institute is in the process of expanding the research programme into other species of this group of plants.

Proteas

Breeding - Release of the *Protea repens* cultivar Guerna aroused widespread interest. A number of new winter-flowering *Protea* and *Leucospermum* cultivars look promising and should be released to the industry soon.

Crop science - The vegetative propagation of protea cultivars has always been a problem in the industry. Attention was therefore given to the multiplication of proteas by means of tissue culture and results of this work have shown that proteas can be multiplied successfully through tissue culture.

PLANT PROTECTION RESEARCH

National collection of insects

Specialised taxonomic studies

Parasitic wasps - Studies on the African parasitic wasps of the superfamily Chalcidoidea are continuing, with emphasis on the Encyrtidae and Aphelinidae, two families of extreme importance in the biological control of insect pests. In this regard a major study on a group of egg parasites was completed during the year.

Aphids and scale insects - A detailed taxonomic study of the smaller subfamilies of South African aphids is being completed at present. An updated list of all the aphids and their regional host plants has been published. A preliminary study of scale insects was started that enabled the National Collection to provide an extensive identification service for the first time in many years.

Neuroptera (lacewings and allies) - Accessions of the Southern African fauna increased to over 7 000, making it the most comprehensive reference collection available.

Curculionidae (weevils) - The collection of these important phytophagous insects has now grown to one of the most extensive of its kind in Africa and contains valuable host plant information. The collection of weevils was increased to 34 345.

Hymenoptera aculeata (bees and wasps) - The collection of wasps and bees, many of which are important pollinators, has been expanded by about 3 000 specimens and now stands at 52 000, making it one of the largest reference collections of Hymenoptera aculeata in Africa.

Biological and integrated control

American bollworm - An "expert system" to assist pest controllers in decision-making was developed. This system is a user-friendly computer program which is based on a series of questions and answers relating to the cotton pest complex, threshold levels, the cost of insecticide applications and the benefits of biological control. The program gives special attention to the control of key cotton pests, such as the American bollworm, *Heliothis armiger*, and red spider mites. The holistic approach of descriptive analysis for cotton is considered a model for examining the pest complexes and determining research priorities for other crops. Predation of American bollworm pupae and pitfall catches of predators over the past two seasons have revealed high levels of mortality (up to 70%) caused by about 20 different predator species.

Stem borers - The grain sorghum stalk borer *Chilo partellus* has emerged as an important pest of grain sorghum and maize in its own right. Studies have revealed several "new" parasitoids which had not previously been recorded on this pest in South Africa.

Imported natural enemies of insect pests - The quarantine service cleared 10 consignments of imported natural enemies comprising 18 species of insect parasitoids and predators and one pathogen. These importations were conducted on behalf of seven research institutions in the Department and the private sector which serve the citrus, cotton, forest, sugar and livestock industries.

Cotton mites - The effectiveness of abamectin was compared with that of triazophos under field conditions. The cost of the product per hectare is extremely high, but particularly since spraying with triazophos has decreased drastically in effectiveness over the past few years, the evaluation of abamectin was regarded as being practical and necessary. In two trials, one done in the region of Marble Hall and the other in that of Groblersdal, it was found that abamectin is far more effective than triazophos. Abamectin's effectiveness is heightened in particular under conditions where predators are present and the product's poison does not seem to have much of an effect on predators. The plots sprayed with abamectin yielded a crop that was approximately 20% larger than the crop in those plots sprayed with triazophos, in spite of the fact that the abamectin plots were sprayed only once, whereas in those towns there were four and five sprayings of triazophos, respectively.

Insects in stored grain

The investigation into the resistance of insects to phosphin gas was continued during the year under review, but problems are still being experienced with heterogeneity in the reaction of exposed insects. A new apparatus was built to overcome this problem.

Because it takes so little time to travel to the harbour, phosphin gas can no longer be used as the preparation for fumigating grain during the journey, since this gas requires a period of exposure of at least 4 days. A much shorter period of exposure is possible with methyl bromide as the fumigation agent and two truck fumigation trials were carried out using this gas to clear up certain problems. Excellent results were obtained in stationary trucks with relatively low concentrations of gas and a period of exposure of only 6,5 hours.

Bee research

Using analysis of pollen and physical characteristics of honey it was possible to trace efforts to falsify honey. Various samples of other "problem" honeys were also examined and the main cause of the unnatural taste seemed to be contamination with creosote.

The bee breeding programme reached a further stage. Selected queens from the Robben Island breeding programme are now being returned to the Transvaal for evaluation under local nectar conditions.

Forest and timber insects

There were no outbreaks of the black pine aphid in pine plantations during the past year. The aphid was attacked vigorously by the imported parasite, *Pauesia* sp., which has in the meantime spread to all pine areas in the country. In spite of heavy infestations of the parasite, it is not yet certain that it will keep the aphid completely under control.

Studies of the three aphid species found in pine plantations indicate that the black pine aphid has a clear preference for trees with a strong growth habit, while the pine blood aphid and the pine needle aphid prefer trees where growth is slightly inhibited.

African migratory locust

For the eighth successive year small outbreaks of this locust occurred in the Orange Free State and Western Transvaal and control was carried out in some eight districts.

Aerial spray trials were conducted against the African migratory locust using the synthetic pyrethroid *deltamethrin* sprayed as an ultra-low-volume formulation. Good results were achieved at doses as low as 7,5 g of active ingredient

per ha and the moderate persistence makes this chemical potentially useful for the spot spraying of headlands and oviposition sites to control emerging hoppers.

Harvester termites

Trials carried out in the Free State and the Northern Transvaal using two commercially available baits caused a marked decline in termite activity, but did not eradicate the termites. Both baits proved attractive to foraging worker termites. Preliminary trials with the synthetic pyrethroids, *cypermethrin* and *alphamethrin* gave unsatisfactory results.

Economic Zoology

National collection of nematodes - During the year under review 1 130 soil and plant samples were examined, namely 180 for farmers and other private persons and bodies, 200 flowering bulb and seed samples and 590 ornamental plant samples for the Directorate of Plant and Seed Control and 160 samples taken during survey trips.

Taxonomic studies were made of the genera *Scuttellonema, Criconemella, Meloinema, Hemicycliophora, Rotylenchus* and *Zygotylenchus*. Three new species of the genus *Rotylenchus* were described.

Root-knot nematode - Various crops, including lucerne, were surveyed for root-knot nematodes at 78 localities in Natal and the Transvaal. A previously unrecorded root-knot nematode species that is known to damage rice, wheat, sorghum, bananas, potatoes and tomatoes has been identified in the eastern Transvaal.

National collection of Arachnida - Accessions of mites amounted to 220 and those of spiders to 455. A total of 956 identifications of mites were carried out, and the areas from which mites were identified included Zimbabwe, Mozambique, Swaziland, Reunion and Venezuela. The identifications represent 108 species, with 46 of these being phytophagous species. A total of 1 441 identifications of spiders were carried out.

Plant pathology/Microbiology

Mycology

National collection of fungi - Efforts to improve and expand the services offered by the Mycology Research Unit have proved to be a great success. The number of fungi identified doubled in the past year. Of these 90% were of direct importance to agriculture.

Toxigenic fungi - A total of 59 feed samples were investigated for the presence of toxigenic fungi. The most commonly found fungi were once again *Aspergillus flavus, Fusarium moniliforme, A. clavatus* and *Scopulariopsis brevicaulis*. A number of sorghum samples were found infected with *Claviceps* sp. It was found that some *Fusarium* species isolated from medic seed were highly toxic to ducklings and lethal to sheep.

Fungal diseases of proteas - Stem cankers and die-back of *Protea* spp. caused by *Botyrosphaeria dothidea* were found to be associated with wounds caused by pruning, flower harvesting and insects. Control of the disease by application of fungicides to protect pruning and harvesting wounds was improved by concurrent chemical control of pests. Rainfall and temperature were the most important factors affecting the production and release of spores in the field. Inoculum levels of the fungus were greatly reduced by pruning away dead plant parts and removing these from the orchard.

A method of screening pincushion cultivars for their resistance to Drechslera blight under controlled conditions was developed. The cultivars Scarlet Ribbon and Luteum were highly resistant to Drechslera blight.

Phytophthora root rot in indigenous forests - A survey of dying stinkwood trees in the southern and south-eastern Cape Province in 1985 revealed that *Phytophthora cinnamomi* was a major factor contributing to the decline and mortality of these trees. Other indigenous trees were also affected. The role of logging activities in providing conditions favourable for the disease is currently being investigated.

Fungal diseases of pasture legumes - Under glasshouse conditions, cultivars of six annual *Medicago* spp. differed significantly in their resistance to Colletotrichum crown rot. *M. truncatula* cv. Borung and cv. Cyfield were the most resistant. The yield and quality of *Lotus corniculatus* pastures were lowered by root rot caused by *Fusarium* root rot and *Phoma verticillium*.

Forest tree diseases - *Leptographium procerum* was found in South Africa for the first time. This fungus is associated with a serious disease of conifers in the Northern Hemisphere. In this country the fungus appears to be carried by root-feeding bark beetles such as *Hylastes angustatus* and *Hylurgus ligniperda*. These insects will provide a means for long distance dissemination of the fungus.

Sphaeropsis sapinea is considered to be one of the most important pathogens of pines in South Africa. It causes severe losses to certain pine species after hail damage. Difficulties experienced in isolating the fungus from roots and older tissue have been overcome by developing a selective medium. This medium will provide a significant boost to research on *S. sapinea*.

Severe cases of cypress canker have been reported from various parts of the South-Western Cape during the past year. It has been determined that two fungi, *Seiridium unicorne* and *Seiridium cardinale*, cause this disease.

Bacterial diseases

The purification of bean seed from pathogen bacteria was continued during the year under review

and a further six dry bean and five green bean cultivars were purified. The stage has now been reached where purified seed is used for 75% of all dry bean plantings in South Africa.

A start was also made on the purification of soya bean seed and small amounts are already available from eight cultivars for multiplication.

Biological nitrogen fixing

Efforts to obtain or develop still better legume inoculant races of *Rhizobium* and *Bradyrhizobium* for supply to inoculant manufacturers were continued. This continued research, together with strict quality control of manufactured inoculants, has resulted in it being possible to increase the minimum requirements from 5×10^8 nitrogen-fixing bacteria per gram of inoculant to 1×10^9 per gram. Inoculants are at present being manufactured for all the most important legumes cultivated.

Virus diseases

It was proved that grapevine leaf roll and grapevine stem-grooving virus diseases can successfully be eliminated by tissue culture.

This breakthrough should greatly assist in obtaining grapevine sources free from the economically important grapevine leaf roll and stem-grooving diseases.

Preliminary results showed that it is possible to detect a virus within 24 hours by using the Eliza procedure direct in petiole extracts of field-collected grapevine material. Studies are at present in progress to develop this screening test in a kit form.

The grapevine mealybug, *Planococcus ficus*, was shown to be a vector of grapevine leaf roll disease. These findings are of great concern to the table grape producer in view of the damaging effect of the disease on quality because of poor colouring and reduced sugar levels at harvest time.

The detection of double-strained RNA (ds RNA) as a broad spectrum indicator of virus infection is at present under investigation for virus-like graft-transmissible diseases of grapevines and deciduous fruit of unknown aetiology which comprise more than 80% of the diseases of the above-mentioned crops in this category.

Weeds research

Biological control of weeds

Lantana - The numbers of the two already established leaf-mining beetles, *Octotoma scabripennis* and *Uroplata girardi*, are already increasing slowly along the Natal coast. *Teleonemia scrupulosa*, the leaf-sucking insect, has built up large populations at various places inland, so that the lantana there is totally without leaves. Such large populations are found every few years, especially when the summers are dry. Along the coast, in contrast, the numbers of *T. scrupulosa* were low. Various other insects are still being evaluated for controlling lantana.

Water hyacinth and water lettuce - The snout beetle *Cyrtobagus salviniae*, was obtained for the control of *Salvinia molesta*. In September 1985 core cultures of *C. salviniae* were placed in breeding dams in the Northern Transvaal. Specific snout beetles were imported from Australia for both water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*). *Neohydronomus pulchellus* was established on water lettuce in the northern part of the Kruger National Park. Releases of *Neochetina eichhorniae* were made on water hyacinth in the Crocodile River west of Brits, the Hectorspruit region in the Eastern Transvaal, the Enseleni River in Natal and two places on the Vaal River near Parys.

Harrisia cactus (*Harrisia martinii*) - Since the release of the mealybug, *Hypogeococcus festerianus*, on Harrisia cactus near Muden in 1984, large clumps of the plant have died and the need for chemical control has become obsolete. The manual distribution of the insect to new infestations is essential for further success.

Sesbania - An extensive campaign to redistribute the bud-feeding weevil, *Trichapion lativentre*, and the seed-weevil, *Rhyssomatus marginatus*, to infestations country-wide was launched. Both insects established well and the prospects for a high level of biological control of this weed are good, as is indicated by data obtained from regular sampling and survey programmes. Surveys in Natal have revealed that *Trichapion lativentre* is widespread.

Acacias - In addition to reducing seed production of the long-leaved wattle, *Acacia longifolia*, it has been shown that the bud-galling wasp, *Trichilogaster acaciaelongifoliae*, also significantly suppresses the vegetative growth of this weed. Further releases of the wasp were made in Natal.

A number of fungal pathogens have been identified as potential biological control agents for the control of woody Australian invasive weeds after a three-year visit to Australia by a plant pathologist of the Institute. Application has been made for permission to release one of these pathogens, a rust fungus, *Uromycladium tepperianum*, for the control of Port Jackson wattle, *Acacia saligna*.

Chemical control of weeds

Jointed cactus - Evaluations of imported and locally manufactured wetting agents for addition to MSMA for the control of jointed cactus showed that MSMA without any wetting agent does not lose any of its effectiveness. The application for registration of MSMA without any additives is being prepared and, if it is succesful, this will result in a saving of approximately 20% on the jointed cactus spraying account.

Imbricate cactus - Spraying trials have

established that MSMA can be used successfully against imbricate cactus.

Nassella tussock - An investigation in which various grasses and one legume were selected for their sensitivity to tetrapion residue in soil, for possible oversowing purposes, showed that, even at the highest dose, hairy patches are not sensitive to tetrapion. Grasses such as Smuts finger grass, tall fescue and perennial ryegrass will also fit well into an oversowing programme.

Silver wattle (*Acacia dealbata*) - Basal stem applications of diesel oil to the lower 0,75 m portion of stems has been found to cause 100% mortality of treated trees. Final assessment of trials showed that picloram + 2,4-D (Tordon 101) provided consistently effective control. The effect of ring-barking was also investigated. One year after treatment, no regrowth has occurred. This technique may therefore be of great value for the control of silver wattle.

Pereskia (*Pereskia aculeata*) - Applications of herbicide solutions, to which surfactants were added, to the foliage of Pereskia was found to improve efficacy markedly. Approximately 90% mortality of the top growth was obtained.

American bramble (*Rubus cuneifolius*) - Trials aimed at comparing the efficacy of triclopyr and glyphosate applied to bramble growing in grazing veld have been conducted. Application to foliage in late summer showed that both herbicides were effective at the four sites, resulting in a mean of approximately 80% mortality. Marked differences in the grass cover following treatment were observed. One year after spraying, triclopyr treated plots had a mean grass cover of 85%, compared with 25% for the glyphosate plots. Triclopyr is therefore more suitable for controlling bramble in grazing lands.

Bugweed (*Solanum mauritianum*) - Cut-stump and basal-bark herbicide treatments applied to tall trees were very effective. Results obtained confirm that bugweed is very susceptible to many of the available herbicides applied by a variety of techniques.

Ecology and physiology of veld invaders

Nassella tussock - Pot trial results for determining the relative reaction of nassella tussock to increased soil fertility show that the application of nitrogen at 240 kg/ha suppresses nassella tussock, while tall fescue (*Festuca arundinacea*) reacted positively to the application of nitrogen. This information is significant in the light of the fact that a few legumes look promising for oversowing purposes where nassella is sprayed and killed using tetrapion.

Pesticide dynamics

The use of pesticides to control insects, plant diseases and weeds continues to be a major factor in plant production. Problems encountered with the use of pesticides are usually solved by the manufacturer or by economic plant protection researchers. Problems of a more fundamental nature are often referred to this section for further investigation. During the past year progress has been made in the following research areas.

Herbicide application - The effect of leaf surface characteristics on the retention, wetting, spreading and penetration of herbicides was investigated further. A preliminary leaf classification system based on wetting, assessed by percentage cover, and spreading, assessed by droplet size and retention of the droplets, seems to be useful to categorise leaf types into easily wettable and hard-to-wet surfaces.

Pesticide residues - Not only are pesticide residues in foodstuffs undesirable, but it has become evident that residues of herbicides and soil systemic insecticides may have an adverse effect on follow-up crops. Trials with tebuthiuron used to control indigenous bushes were completed and proved conclusively that thin herbicide persists for a long time in soils. Carbofuran used extensively to protect summer grain seeds proved to be difficult to analyse. Methods are still being developed to improve the analysis of this important compound in soils and crops. The presence of dieldrin in fresh milk continued to be a problem.

Improvement of analytical methods - Previously it has been reported that algae can be used successfully to determine photosynthetic inhibiting herbicides. During this year this system continued to be used to determine herbicides in soil sample adjuvants and to investigate the dimethoate-bromacil interaction. However, since the use of this system is limited, a cell culture system was investigated to broaden the analytical range. Success was achieved with the culture of a bean cell culture line. This cell line and others will be used to develop bio-tests for other herbicides.

To improve the credibility of analytical results produced in pesticide laboratories in South Africa this Section was instrumental in the preparation and performance of six inter-laboratory calibration exercises during the past year. These include both formulation and residue analyses. Results were presented to the Interdepartmental Advisory Committee Safeguarding Man against Agricultural Poisons to enable the Government departments involved to discriminate between results of tested and untested laboratories.

Technical advice

Some 800 applications for registration and amendments to existing registrations of insecticides, fungicides and rodenticides and some 350 applications for herbicides, plant growth regulants and swimming pool remedies have been reviewed and recommended for registration (Act 36/1947) by the technical advisers.

Almost 2 000 applications for reregistration have also been dealt with.

The annual departmental communication "A guide to the use of pesticides and fungicides in the Republic of South Africa" was extended and updated and appeared again during August 1985 (312 pages).

The Afrikaans version of this guide "Handleiding vir die gebruik van plaagdoders en swamdoders in die Republiek van Suid-Afrika" was also extended and updated and appeared during February 1985 (297 pages).

The publication "List of registered herbicides" (1982) was completely revised and extended to give more detailed information regarding the use of herbicides. It was published in June 1985 under the name "A guide to the use of herbicides" (83 pages).

In addition "A guide to the use of plant growth regulants, defoliants and desiccants" (Jan. 1986 - 22 pages) was published giving detailed information on the use of these compounds.

The Senior Technical Adviser (Insecticides and Fungicides) to the Registrar (Act 36/1947) attended the 17th session of the FAO/WHO Codex Alementarium Committee on Pesticide Residues in the Hague in view of the importance of pesticide residues on our edible export commodities. Active participation in the activities of the Committee during the year under review was impossible because FAO has cut all communications with South Africa.

ANIMAL PRODUCTION RESEARCH

Large stock

Nutrition - At the Animal and Dairy Science Research Institute, Irene, research was undertaken into the extent to which two different maize cultivars that differ in hardness in whole grain diets are utilised by Bonsmara steers in a feedlot. The average daily mass increase of steers on the softer maize cultivar was considerably higher (1,55 as against 1,21 kg/day) than that of those on the harder cultivar. The effectiveness of the softer cultivar (4,33 kg against 5,29 kg feed consumption/kg mass increase) was significantly better.

Strategic concentrate supplement was given to yearling beef steers on summer veld and fertilised summer veld at Potchefstroom for finishing purposes. At the current meat prices the income in excess of feed costs in respect of the supplement groups was higher than that of those that did not receive the supplement. The higher incomes per steer that were obtained with the supplement were of the order of R10,00.

In contrast to this, a protein/energy supplement for first calf and adult cows on veld in the highland - sour veld area of Natal, did not appear to be economically viable. The cows that received the protein/energy supplement utilised the veld at a grazing pressure of 1,0 cow plus calf per hectare.

On the Bathurst experimental farm kikuyu utilisation for milk production was investigated. Dairy cows were subjected to grazing rotations in which the pasture has rest periods of 15, 30 and 60 days. The dairy cows were given no concentrate. The highest production per cow was maintained at a 30-day rest period. This was also coupled with the highest percentage of butterfat (3,7%) and crude protein (3,3%).

Research into lactating Friesland cows that was conducted at the Animal and Dairy Science Research Institute, Irene, showed that maize can be totally replaced by grain sorghum in a dairy cattle diet without any adverse effect on feed intake or milk production. A similar conclusion was reached at Potchefstroom, where researchers established that maize meal can be partially or totally replaced by grain sorghum in the concentrate for dairy cows.

The protein degradability of diet components forms an integral part of various new protein evaluation systems. At the Animal and Dairy Science Research Institute, Irene, a start was made on building up a protein degradability data bank. Up to now 13 protein components have already been evaluated, and the degradability varied from 26% (blood meal) to 93% (whole sunflower seed). The aim of the study is to lower the total protein content of the diet with the strategic combination of protein sources, without a loss in production.

The concentrate part of a balanced ration was given to dairy cows at Glen in two, four or eight portions. Lucerne hay was available *ad libitum*. The same quantity of concentrate was provided in four or eight portions instead of two, over a period of 24 hours. During early lactation the cows that were fed concentrate twice a day consumed 8,25 kg of lucerne hay as against the 10,08 and 11,04 kg of lucerne hay consumed by the cows fed four and eight times, respectively. The higher crude feed intake and digestibility of the ration resulted in an increase of 2,86 litres to an average of 27,17 litres of milk per day in the case of a feeding of eight times. This group of animals also produced an average of 154,6 g of butterfat per day more than the other cows. Varying results were obtained during mid and late lactation.

In the *Winter Rainfall Region* the use of ammoniated small grain straw, housing and the implementation of a mastitis control programme was studied. Ammonia treated wheat straw by itself or in combination with lucerne and oat hay was fed to lactating dairy cows and growing replacement heifers as a roughage component. Provisional results indicate that a combination of two thirds treated wheat straw and one third hay can result in economic production and growth. Treated wheat straw as the only source of roughage produced unsatisfactory results.

According to provisional results, cows that have access to shade tend to eat more fodder and produce more milk. These cows also came on heat faster after calving.

According to tests at Potchefstroom, Friesland bull calves can be profitably reared for the production of veal at an age of five months. It was proved that a gross margin of R98 per calf can be obtained with an optimum concentrate/roughage ratio of 77,5:22,5.

Breeding - Data from the Departmental Nguni herd, which at present consists of 207 female animals, were used during the year under review as a model for the study of possible selection norms for mother lines in the case of beef cattle. It was found that the equation (weaning index of calf/calving interval) x 365 days can be a valuable selection norm for cows of mother lines. This equation shows advantageous relationships with pre-weaning growth of the calf and with the calving interval of the cow, while it is independent of the birth mass of the calf and the mass of the cow. Feed conversion cannot be evaluated on all bulls and consequently an alternative criterion of feed conversion was sought. It was found that the Kleiber ratio (growth tempo/mass 0,75) can be a valuable selection norm, since it is to a large extent correlated with feed conversion, while it does not have other disadvantages worthy of mention.

At the request of the Gene Bank Committee the Animal and Dairy Science Research Institute began research into the influence of the import of germ plasma on the stud stock industry. It would appear that there is a heavy dependence on imported semen which has the danger that the genetic base of the animal material in the country may be narrowed. In one dairy breed, for example, 39% of all semen that is imported comes from one blood line. In two beef breeds 45% and 36%, respectively, of the semen that is imported comes from only one bull.

Reproduction - Studies into the genetic abnormality of gonadal hypoplasia in Nguni bulls points to a correlation between the lumen diameter of the testis artery and the mass of the testis which is supplied with blood by this artery. The absolute blood flow was significantly correlated with the diameter of the corresponding artery. The average total testosterone secretion values for the normal and hypoplastic testes were 682 and 243 ng/min, respectively.

At Dohne the reproduction performance and hormone status of Bonsmara heifers on sour veld and sweet veld were studied. Animals on the mixed sweet veld annually yield a significantly higher calving percentage of 20% to 30%.

Small stock

Nutrition - The performance of mutton ewes and lambs on Midmar ryegrass at Cedara at 5 stocking rates showed better results than the previous year. The lambs were weaned after being on pasture for 91 days at 23,5; 23,00; 21,9; 21,75 and 17,5 kg. The respective stocking rates were 20, 24, 28, 32 and 36 SSU/ha.

At Potchefstroom it was found that woolled sheep that use Smuts finger grass as standing hay, with the provision of a nitrogen lick at a rate of 8,3 sheep per hectare during the winter period of 180 days could maintain their mass.

At Dohne research was done into the influence of the stocking rate on the overwintering of ewes and lambs on winter veld. In spite of good supplements, the higher stocking rate caused the daily mass loss in ewes to increase by 29% and lamb growth to decrease by 14%.

In their research programme to evaluate the nutritional value of various types of sorghum, researchers at Potchefstroom showed that sheep successfully accept sorghum silage, and that additions to stimulate intake are not necessary.

In the Winter Rainfall Region urea-supplemented and urea-ammoniated wheat straw was compared as a roughage source in the summer rations for late-bearing and lactating ewes. Results show that there is no economic advantage in the feeding of urea-ammoniated wheat straw rather than urea-supplemented wheat straw.

In a study in which enriched barley and wheat were fed to early-weaned lambs in the Winter Rainfall Region as a finishing ration, it was found that these grain rations result in definite economic advantages.

According to blood and liver analyses, sheep in the Outeniqua area experience definite shortages of copper and selenium. Results show that supplements effectively increase the blood and liver levels and significantly improve growth, wool production and reproduction. In addition, the animals display a seasonal pattern, with a low in the spring and early summer for both trace elements.

Breeding - A study into the phenotypical and genetic aspects of the reproduction rate in the Tygerhoek Merino flock in the Winter Rainfall Region was completed. Results show that reproduction is to an extent hereditary and repeatable and that selection progress is possible in the existing flock and in future generations. Furthermore, results show a possible negative genetic correlation between wool production and lambs weaned per ewe mated. The genetic and phenotypical relationships between the body mass and reproduction were significantly positive.

At Dohne a genetic control flock for the Dohne Merino is being developed and maintained and the first test rams from this flock were made available during 1986.

In a study done on the breeding progress with the Dohne flock between 1960 and 1984, it was found that the annual genetic progress was 0,86% and 0,48% for body and crude fleece mass at the age of 18 months.

The development and evaluation of a white woolled mutton breed to use as a fatherline on Merino ewes was completed. The Afrino (25% Merino, 25% Ronderib-Afrikaner and 50% SA Mutton Merino) evolved as a result of these developments and a breeders' society for this breed has existed since as far back as 1980. By crossing the Afrino with the Merino a good slaughter lamb is obtained without the danger of wool pollution with kemp and coloured fibres.

The Afrino also performs well above expectation as a pure breed. In arid conditions at the Carnarvon Experimental Station the breed maintains an average reproduction percentage of 140% with an average weaning mass of 28 kg at the age of 100 days. The wool production is 4,2 kg of crude wool per ewe per year with an average fibre thickness of 22,1 microns.

In a study at Glen the reproduction performance of Dorper ewes was increased under semi-intensive conditions by crossing with Romanov rams. The cross ewes and Dorper ewes' pregnancy and weaning percentages and fecundity were 97,1 against 90,9; 154,0 against 98,5 and 198,6 against 141,8, respectively.

The F1 ram lambs (1/2 Dorper, 1/2 Romanov) showed faster growth rates than the Dorper ram lambs. However, the Dorper lambs grew better than the F2 lambs (3/4 Dorper, 1/4 Romanov). In terms of the margin above feeding costs the cross ewes performed better than the Dorper ewes, but the system was still not profitable at the current meat price/feed price ratio.

Reproduction - Reproduction physiologists at the Animal and Dairy Science Research Institute are currently devoting attention to the low conception

figures which are obtained with frozen sheep semen. Although 50% of the ewes, after insemination with locally frozen semen granules did not show oestrus again at 27 days after insemination, the situation changed drastically after 47 days, and almost 87% more came on heat.

These results indicate a possible high embryonic resorption. Frozen semen which is packed in straws resulted in conception figures 68% higher than semen that was frozen in granule form.

Pigs

Nutrition - Various studies were carried out at the Animal and Dairy Science Research Institute with a view to the evaluation of different feeds for pig production. It was found that the digestible energy values of ground sunflower seed and ground shelled sunflower seed were 19,7 MJ/kg DM and 28,6 MJ/kg DM, respectively. The whole form of the two components is utilised only approximately half as well by the pig as the ground form. Sunflower seed meal's energy value compares favourably with that of a product such as full-fat soya bean meal which can make it a useful inclusion in pigs' diets.

In a further study sweet white lupins were evaluated as an alternative to heated full fat soya bean meal for early-weaned piglets. Two experiments were conducted, one with commercially produced lupins with an alkaloid content in excess of 0,05% and the other with certified seed containing only 0,01%. The high alkaloid seed depressed feed intake by 21%. The low alkaloid seeds had no effect on feed intake. Growth rate was retarded by 25% when high alkaloid seeds were used, but by only 6% when low alkaloid seed was used. The utilisation of digestible energy was reduced by 2 to 4% with lupin inclusion.

Back bacon samples from boars and young sows that received maize or wheat based diets up to 85 or 120 kg mass were analysed. The refraction index (R.I.), saponification value (S.V.), iodine count (I.C.) and fatty acid composition were determined. The only significant difference between the sexes was in myristic acid, where young sows had slightly more than boars. A small but very significant dietary effect on linoleic acid content was observed. The pigs on the maize diet had more (11%) linoleic acid than the wheat-fed pigs (9,4%), which indicates a less saturated fat. The heavier baconers (130 kg) had a more saturated fat than other baconers. Wheat as a source of grain therefore led to a better quality bacon, and heavy baconers have a better quality bacon than baconers.

Ostriches

Nutrition - The first basic research into fibre digestion by and energy metabolism of ostriches in the Winter Rainfall Region was undertaken in co-operation with the Animal and Dairy Science Research Institute. Information from this study has already contributed to the establishment of guide-lines for the registration of ostrich production diets.

Reproduction - Very good progress has been made in the field of reproduction effectiveness and hatching physiology. The fertility and egg production of the existing breeding herd at the Oudtshoorn Experimental Farm were increased by 33% and 66%, respectively. This was obtained by the improvement of mating management with regard to the peak hatching seasons, the application of rest periods and the use of complete laying diets. Furthermore, the most important incubation parameters, namely incubation temperature, the absolute incubation humidity and the compulsory mass loss of incubating eggs were measured in ostrich nests with the aid of both conventional thermometric and advanced diffusion hygrometric techniques. Extrapolation of the results to the artificial incubation process indicated the possibility of an increase of 55% in incubation results.

Water birds

Research investigating the optimum protein levels required to produce maximum growth in Chinese goslings during the starter period was continued. Experimental diets containing the same energy level, but different protein levels, namely 20, 22, 24, 26 and 28% protein were fed to day old Chinese goslings up to three weeks of age. Optimum growth was achieved on the 26% protein diet.

Restricting the feeding of ducks at an earlier age (three weeks) appeared to be more beneficial than at a later age (eight weeks). Results showed that the *ad lib* fed ducklings were the heaviest, averaging 3 154 grams at eight weeks with a feed consumption per duck of 7,4 kg, whereas ducklings fed 50% *ad lib* averaged 2 117 grams with a feed consumption per duck of 3,7 kg.

Basic animal research

Nutrition - The efficiency of protein utilisation in ruminants is dependent on the efficiency with which micro-organisms in the rumen synthesize protein from nitrogen. This in turn depends on the rate of energy supply to the micro-organisms. An experiment carried out at the Animal and Dairy Science Research Institute with various feed grains (energy sources) showed that each grain has its own characteristic fermentation pattern and that grains can be combined on the basis of these patterns to yield a more desirable fermentation pattern. This implies that feed grains can be strategically combined to give an energy supply pattern in the rumen which will result in more efficient conversion of nitrogen to microbial protein that is available for ruminant metabolism.

Research into the control of partitioning of nutrients in high-producing ruminants progressed along several fronts. Data obtained on lactating ewes and dairy cows showed that exogenous growth hormone may raise milk production by 20-25% by redirecting the precursors of milk protein and

butterfat from muscle and fat to the udder (by increasing lipolysis from fat depots and the release of small peptides from muscle). While whole-body glucose entry rate did not change with growth hormone treatment, udder uptake of glucose increased sufficiently to account for the increased lactose output in the milk.

Experiments on the efficiency of digestion and nutrient utilisation were carried out on Dohne Merino wethers fed either a low or a high roughage diet. Preliminary results suggest that the high concentrate diet is more efficiently utilised than the high roughage diet. This difference is correlated to the pattern of ruminal fermentation end products. The high roughage diet produces predominantly acetate and little propionate and leads to a reduction in the glucose pool, whereas the high concentrate diet encourages glucose production. Since catabolism of glucose is energetically more efficient than that of acetate, the high concentrate diet will be more efficiently used for production.

Genetics

Good progress was made with the new research programme on the typing of the antigens of white blood cells in cattle. For this purpose mono-specific antisera are needed, and these are obtained by immunisation and absorption. Reasonably high titre antibodies were obtained with a single subdermal skin graft. In this way the first 12 reagents that were produced have already been tested on almost 1 000 animals. The gene frequencies that were calculated for four breeds, namely the Bonsmara, Brahman, Friesland and Nguni, display interesting breed differences.

The Animal and Dairy Science Research Institute has entered a new phase in raising the production of Merino sheep by acquiring seven rams of the highly fertile Booroola Merino strain from Australia. These rams are currently being used to upgrade a Merino ewe flock that has been donated to the Institute by the Merino industry for this purpose.

Cytogenetic research into the occurrence of the 1/29 chromosome translocation in the indigenous Nguni cattle has shown an incidence of 10,2%. This is coupled to reduced fertility and an increased growth rate in carrier animals. The increased growth rate is not observed in *Bos taurus* crosses. The translocation found in SA Brahman cattle has been traced to cattle imported from the USA. This abnormality is restricted to the descendants of these imported cattle.

ANIMAL PRODUCT RESEARCH

Milk and dairy products

Experimental animal studies into the influence of potentially toxic unsaturated fatty acids that arise during hardening processes of vegetable oils are carried out by the Animal and Dairy Science Research Institute. It has already been found that these fatty acids can be potentially dangerous in the human diet.

It has been established that thermisation of milk for prolonging the storage possibilities for cheese making can be used on good bacteriological quality milk, but does not improve the quality of poor quality milk.

Owing to the increased cost of sucrose in South Africa, investigations into the better utilisation of lactose by increasing its sweetening properties by hydrolysis into glucose and galactose have been successfully carried out.

Casein and caseinates are being imported into South Africa at very high prices owing to the adverse exchange rate. The work on this facet has resulted in the possibility of manufacturing these products with existing cheese making and milk powder equipment and commercial production has already begun.

Meat and meat products

The qualitative study of microbiological populations at the abattoir, wholesale and retail levels was completed. The results showed that the decomposition organisms (pseudomonades) appear most frequently. It was found that the pseudomonades prevail at the abattoir and retail level and the gram-positive cocci at the wholesale level.

There is therefore a shift in the composition of the population from the abattoir to the wholesaler and from the wholesaler to the retailer. No *Salmonella* spp. were identified and, although a fair number of *Staphylococcus* spp. (13%) were found, at no stage did this constitute a health hazard or risk.

The quantity and quality of the organisms on the carcass, the personal surfaces of staff (hands and clothes) and the work surfaces make a significant contribution.

There is considerable uncertainty in the meat trade as to whether fat-tailed sheep should be marketed as such, or whether the tail should be removed when the carcass is dressed before marketing and the carcasses then graded using the same criteria as for non-fat-tailed sheep. Preliminary results indicate that it would be advantageous to the producer if the fat tail was removed during the dressing procedure. Although it may be possible for a carcass to be graded as a Super Lamb or a Top C if the tail is removed, it appears that the subcutaneous fat percentage of such a carcass would, on average, be higher than that of non-fat-tailed carcasses in these grades.

Chilling is important in the preservation of carcasses. It could, however, also have an adverse effect on meat tenderness. A study aimed at determining the effect of chilling temperature and carcass mass on meat tenderness (shear force value) was carried out at the Animal and Dairy Science Research Institute. The researchers concluded that smaller carcasses (with lower fat coverage) chilled quicker than carcasses of a higher mass and this resulted in a higher degree of toughening. The more

Pathologists of the Veterinary Science Research Institute at Onderstepoort discussing a diagnosis around a group microscope

A typical case of *Cotyledon* poisoning

Three of the 36 indicator donkeys used in a country-wide survey to study the transmission of horse sickness

Determining protein degradability by means of the *in sacco* technique at the Animal and Dairy Science Research Institute, Irene

The degradable and non-degradable proteins in urea-ammonified roughage are determined by means of the *in situ* digestion technique at Elsenburg

rapidly a muscle is chilled, the tougher the meat becomes.

To prevent the excessive toughening of meat because of chilling, the smaller carcasses should be chilled at higher initial chilling temperatures to ensure that the temperature in the muscle does not drop to below 10 °C before 10 hours post mortem. Alternatively, all carcasses which have to be chilled rapidly should be effectively electrically stimulated in order to prevent cold shortening and hence toughening.

LIVESTOCK IMPROVEMENT

The Beef Cattle Performance and Progeny Testing Scheme

During the year there was a slight decrease in membership of the scheme. Membership is still, however, a healthy 1 802 with breeders' associations which to an increasing extent make performance testing obligatory. A total of 6 344 bulls were subjected to official growth tests, and this exceeds last year's total by 599. The total number of masses determined on the farms of collaborators was 459 084, which is 79 213 more than last year.

The computer programme integrated with that of the South African Stud Book Association will be put into operation at the beginning of 1987. This programme contains new possibilities and more advanced processes.

The Dairy Cattle Performance and Progeny Testing Scheme

At present an average of 1 743 herds and 99 089 cows are tested per month under the Dairy Cattle Performance Testing Scheme. This shows an increase of 96,1% and 129,8% for herds and cows, respectively, over the past 10 years. The average milk production has increased during the past decade by 17,7% from 3 993 to 4 701 kilograms.

Together with the control tests, 1,2 million tests were done to determine milk mass and butterfat, protein and lactose values.

The number of young bulls nominated for the progeny testing programme was 359, and of this figure 147 were acceptable and 50 were purchased by the AI industry.

Approximately 23 171 first lactation records were examined for bull evaluation. A total of 1 608 bulls were analysed. The results of only 528 bulls qualified for publication.

The Woolled Sheep Performance and Progeny Testing Scheme

Participation in the National Woolled Sheep Performance and Progeny Scheme increased from 620 consignments of wool to 631 consignments. Almost the same number of wool samples as last year (42 000) were tested.

Officers responsible for this scheme also run an Angora goat performance scheme as a pilot project in preparation for a full-fledged scheme when its requirements can be met. At present there are four collaborators, and 1 500 weaning mass analyses and 1 000 fibre thickness tests were handled during the year under review.

The Mutton Sheep and Goat Performance and Progeny Testing Scheme

During the year the Mutton Sheep Scheme developed continuously. The interest in ram tests among mutton sheep breeders continues to increase. The expansion of the Mutton Sheep Scheme took place in Natal and the Transvaal, in particular.

The Pig Performance and Progeny Testing Scheme

During 1985 2 135 boars were taken in for testing, of which 1 792 completed the test. Although the intake figure is 9,9% lower than that in 1984, 8% more boars completed the test and 19% more qualified. The average feed conversion figure improved by 8% and the average fat measurement increased by 3 mm. The average age at test completion decreased by almost three days. This improvement in performance once again emphasises the value of sustained performance testing.

Poultry Performance Testing

The Random Sample Broiler Test at Irene was launched two months earlier than the corresponding test in 1985. The aim was to diminish the appearance of the much-discussed abdominal dropsy (ascites). The average mortality was 3,1% lower.

Outstanding results were obtained. The average production efficiency factors for the ages of 28, 42 and 49 days, respectively, were 227,3, 240,5 and 212,6.

The 20th Random Sample Egg Production Test for 1984/86 at Glen, was concluded during February 1986 on the recommendation of the Advisory Board Committee. The average total egg production was 286,0 eggs per hen for hens on scratch material, and varied from 276,5 to 296,1. A feed conversion of as low as 2,38 was obtained. The average feed conversion for hens in laying cages and on scratch material of 2,53 and 2,45, respectively, was outstanding.

In the Random Sample Egg Production Test at Irene feed conversion was outstanding with an average of 2,64. A favourable feed conversion is important since feed costs at present make up 77,9% of the total costs of a commercial egg producer.

The average egg production at Irene did not really live up to expectations and varied from 232,5 to 268,6 per hen.

DAIRY INDUSTRY DEVELOPMENT

A large number of primary producers were visited on their farms. The hygienic quality of their milk was determined and attention was also paid to stall hygiene and the cleaning of milk machines.

Various producer-distributors were also visited and special attention was paid to the pasteurisation of milk and reinfection after pasteurisation. The reinfection of milk after pasteurisation has often created problems.

The bacteriological quality of water was investigated at various farms and according to the results the total bacteria count per mℓ did not in various cases meet the standards of the SABS.

As a result of the previously mentioned integration of the total plate count into the quality purchase scheme for milk, various purchasers of industrial milk in the Western Cape began doing total bacteria counts of their producers' milk. Initial results showed that only 20% to 25% of the samples met the prescribed requirements for class A milk. These poor results caused producers to make increasing use of both the analytical and the guidance services of the laboratory at Elsenburg in an attempt to improve their cleaning procedures.

BLOOD TYPING SERVICE

During the year under review a total of 5 796 blood samples were received for blood typing. These constituted primarily 1 860 stud bull blood tests and 1 508 parental determination tests which included 702 calf embryos. An increase of 17% in the total number of samples and 20% in the calf embryos was observed. The service provided for the SA Stud Book and Livestock Improvement Association also shows a rise of 77%, (399 as against the 225 calves in the previous year) in the number of calves whose parents had to be checked. These control tests were carried out on 18 different breeds of cattle.

VETERINARY RESEARCH

The research activities of the Veterinary Research Institute at Onderstepoort can be measured by the 32 scientific publications produced by its researchers during the year under review. During the same period vaccine sales increased to 161,5 million doses, while 365 000 specimens were received for analysis. Of these, 1 530 came from outside the RSA. Highlights from research results are the following:

Toxicology

Salinomycin poisoning was again diagnosed in racehorses. Since as yet little is known about the effect of this ionophore antibiotic and growth stimulant on horses, research was done to study its toxicity. A dose of 1-5 mg/kg salinomycin (*per os*) was lethal, while 0,5 mg/kg caused clinical symptoms and 0,25 mg/kg produced no ill effects. The symptoms include sweating, weakness, rapid breathing, respiratory distress, imbalance, cardiac changes, stasis of the gut and recumbency. There are serious disturbances in the heart function, especially in peracute cases. In such cases death is caused by ventricular fibrillation. The most important clinical-pathological deviations also indicate lesions in both the cardiac and skeletal muscle, consistent with the observations at necropsy.

Further research was carried out on the possible treatment of *photo-sensitivity* in sheep and promising results were obtained with a prophylactic treatment against plant poisoning in general.

The chemical pathology, pathophysiology, pathology and possible pathogenesis of *gousiekte* and *Galenia africana* poisoning (*waterpens*) are currently intensively researched. In both these diseases there is significant damage to the cardiac muscle, but while liver lesions are constantly found in waterpens, it is the exception among animals suffering from gousiekte. Heart failure seems to play a role in both conditions, although the course of the disease is more acute in gousiekte than in waterpens. Different parameters are now used to make a closer study of these two diseases.

Research on cardio-toxic glycosides was successfully completed. Eighteen bufadienolides were isolated and identified from the plants *Kalanchoe lanceolata, Tylecodon grandiflorus, Cotyledon orbiculata, Thesium lineatum* and *Urginea physodes*. Twelve were new ones.

During the investigation it was established that some of these toxins have a cumulative effect, and only those with a cumulative action can cause the neuromuscular syndrome. There are also strong indications that only those bufadienolides with a sugar group in the *L*-form have a cumulative effect.

Investigations of *Cynanchum africanum* and *Sarcostemma viminale* revealed that these two plants contain related neurotoxins.

Good results were obtained with the investigation of *Lasiospermum bipinnatum, Albizia tanganyicensis* and *Ornithogalum thyrsoides* and some of the toxins were obtained in pure form.

Bacterial diseases

A marked increase in the number of specimens received for *Salmonella* typing occurred. In 1984/85 465 *Salmonellas* were typed, and this increased to 858 in the year under review - an increase of 54%. Of all cultures received for typing 32% came from rooibos tea. 10% of all cultures received were identified as possible *Citrobacter*.

There were no serious outbreaks of *E. coli* over the past year. Although the number of poultry specimens increased from 72 to 274, this does not indicate an increase in the incidence of the disease, but rather greater awareness of the problem.

Bacterial pneumonias in pigs do, however, seem to be on the increase with 69 cases of *Pasteurellosis* this year compared with eight last year. In most cases *Haemophilus pleuropneumonia* - diagnosed for the first time in South Africa - and *Mycoplasma* spp. were also involved. In contrast, there was a decrease in the number of *Corynebacterium pyogenes* isolations, although *C. equi* - which occurs in the soil - was isolated from several animals. An increase in the incidence of *Streptococcus* in pigs can probably be attributed to secondary infection in cases of pneumonia. The outbreaks of *Streptococcus* infections in *trout* fortunately decreased substantially this year.

Isolation of *Campylobacter* still presented problems and no positive diagnoses were made. Considerable research was done to improve the *Campylobacter fetus venerealis* vaccine. Cultures used for this vaccine must contain a K antigen. A few South African strains have been examined for the presence of K antigen, and two were identified with high concentrations.

The development of a culture medium on which *C. fetus* will produce a high cell yield continues. The amino acid requirements of the three *C. fetus* strains presently used for the Vibrio vaccine were determined to see whether the present culture medium provides for the growth requirements of the strains.

The amino acid requirements of a *C. fetus venerealis* strain that is to be included in the vaccine were also determined. From these determinations it emerged that all four strains require glutamic acid and aspartic acid, neither of which occurs in the currently used culture medium. Optimum concentration of these amino acids is the critical factor that determines optimum growth of the strains.

Campylobacter was isolated from 3% of the sheath washings examined in cases of infertility, compared with 7,5% for Trichomonas. Regarding abortions, *Brucella abortus* is responsible for 90% of the bacterial infections in cattle and *B. Rev. I* for 100% in sheep. It is, however, important to note that only 5-10% of all *abortions* can be attributed to bacterial infections. The causes of the remaining 90% remain unidentified and could include organisms such as *viruses, Toxoplasm, Chlamydia, Coxiella* and *fungi*, and also physiological disturbances, including malnutrition and toxins.

Serodiagnostics of reproductive diseases still form an important part of the solution for this problem. The percentage of positive tests for *brucellosis* remained constant over the past few years as did the percentage of positive CF reactors. This seems to indicate that no further progress was made with the eradication of the disease.

The problems caused in serological surveys by animals that were vaccinated as adults, led to the suspension of the vaccination of adult animals against brucellosis, with a few exceptions.

Leptospirosis is still prevalent, but apparently mostly in subclinical form, as is the case in the rest of the world. *L. hardjo* remains the most common serovar in cattle despite immunisation against it. *L. tarassovi* and *L. mini*, which do not occur in commercial vaccines, are jointly responsible for 34% of all positive reactions.

Interesting results were obtained from continued research on the causes of ulcerative dermatosis in sheep. A new mycoplasm isolate produced an extraordinary colony which later proved to consist of five different organisms that apparently have to be present in a specific ratio to cause the disease. Ureaplasms were also isolated and the possible synergism of these organisms will be investigated.

Food hygiene

Several research facets that dealt with meat hygiene were concluded this year and feed investigations were rounded off with a comprehensive report on the hygienic quality and safety of animal feeds. At present most of the research is aimed at mastitis, udder health and its influence on milk quality.

Good progress was made with the development and use of a very sensitive HPLC technique for determining carbohydrates in milk with a view to studying the relationship between glucose concentration and mastitis. Much attention was also paid to the standardisation of somatic cell counts in milk between laboratories that use this as a routine diagnostic method for mastitis.

The central theme being researched is the dynamic fluctuations of various factors that play a role in udder health. Techniques were developed to determine the activities of cyclo-oxygenases and lipoxygenases in milk and the levels of prostanoid derivatives of arachidonic acid. The ability to accurately determine these substances - known to be mediators of inflammatory processes - makes it possible to make a basic study of all the mechanisms involved in mastitis. It should eventually be possible to devise more effective measures for the control of mastitis than the current virtually exclusive use of antibiotics.

Viral diseases

As in the past, routine diagnostic tests were carried out for the most important viral diseases. Use of the electron microscope was extended to examine specimens for *pox viruses*. Excellent results were obtained with the diagnosis of true *lumpy skin disease*. A hitherto unknown disease, *crocodile pox*, was also diagnosed.

The good rains, especially in Natal, led to an increase in *African horse sickness*, *Rift Valley fever* and *Wesselsbron disease*. The testing of AI bulls for IPV virus involved the largest number of specimens. The Elisa technique was mastered and will in future be used for routine diagnostic tests.

Apart from Wesselsbron virus, three other flaviviruses, namely West Nile, Banzi and an unidentified virus related to Banzi, were identified in laboratory trials as the cause of abortion and congenital defects in sheep. The virus responsible for

sheep-associated bovine malignant catarrh was isolated from cattle and is now reproduced in cattle. Isolation in other systems remains an ideal. A *retrovirus* was also isolated from a bovine with the sheep form of malignant catarrh. This virus is produced in permanently infected cultures. The identity of the virus and a possible relationship between the virus and bovine malignant catarrh has not yet been determined.

Good progress was made with the manufacture of *foot and mouth disease vaccine*. Intensive research revealed several reasons for the failure of the previous year's vaccine. The most important were the selection of vaccine strains that did not give adequate protection or which produced low yields, too early harvesting and excessive inactivation which led to destruction of the antigen and contamination of the carrier-gel with enzymes that digested the virus. Once these problems were solved, experimental SAT-1 and SAT-2 vaccines were again manufactured and on testing they complied with all international standards.

Because strain differences within the accepted three SAT types of the foot and mouth disease virus apparently play such a vital role in cross protection, a start was made with a programme for subtyping field isolates. Isolates will be made - especially in the Kruger National Park - and compared with one another and also with the vaccine strains. Further work on the role of cloven-hoofed game in the spreading of foot and mouth disease led to a better understanding of the behaviour of the virus in the different animals. *Buffalo* seem to be the biggest problem since the disease and excretion of the virus follow a course very similar to that in cattle. In contrast, *Impala* do not seem to be an important source of infection, although large numbers of them may be infected with the virus.

Poultry and fish diseases

Although the poultry industry itself contributes significantly to the diagnostics of poultry diseases, the Veterinary Research Institute still spends considerable time on such activities. During the year under review more than 6 000 post-mortem examinations were carried out and 20 000 serological tests were done.

Ascites remains one of the broiler industry's major problems. Research was especially aimed at clinical markers that can be used for the genetic selection against susceptibility to the disease. Hematocrit determinations were found to be satisfactory for the identification of fowls with hypertrophy of the right ventricle. By using this test it was possible to establish breeding flocks of susceptible and non-susceptible fowls at the Animal and Dairy Research Institute. One big producer has accepted this technique for routine selection.

Other poultry diseases that are being investigated are *E. coli* infections and *turkey malaria*. In the case of the latter disease it could be proved that the pheasant is the natural host of the parasite (*Plasmodium durae*) which causes the disease.

Fish diseases are receiving much more attention with the increasing importance of aquaculture. *Imported fish roe* are examined for the presence of micro-organisms and one consignment was rejected because of the presence of *infectious pancreas necrosis virus* (IPNV). More than 2 000 specimens from nine farms were also examined and certified for *export*.

Biotechnology

The implementation of modern techniques to manipulate the genes of the bluetongue virus (BTV) has progressed well. The S2 gene that contains the information for the protein that stimulates the formation of antibodies has been successfully isolated from two BTV strains and cloned in pBR 322. The 3' and 5' ends of both have also been recloned in M13 vectors for DNA sequencing. This work is now in progress. Good progress has also been made with the recloning in another vector, pGS20. These clones will be used for making vaccinia virus recombinants with a view to developing a unique multivalent BTV vaccine.

An unexpected bonus resulted from the availability of the cloned genome segments of BTV. The possibility was investigated to use these genes as probes for virus identification and both DNA and RNA probes were made of various genome segments and used in cross-hybridization studies. Excellent results were obtained identifying different strains and determining their relationships. New information, supplementary to that yielded by classic serological tests and relevant to the classification of this virus family, was obtained.

Good progress was also made with the construction of genome libraries of *Anaplasma* and *Babesia*. Cross-hybridization between *A. centrale* and *A. marginale* DNA revealed no differences. No final answer can therefore be given to the question concerning the relationship between the two organisms. *Cowdria ruminantium* is the latest organism to be added to the list of candidates for genetic engineering. Efforts are being made to clone its DNA in a vector for further study and use as probe.

Attempts to isolate the jaagsiekte retrovirus' RNA for conversion to cDNA and cloning in an expression vector were also successful and enough RNA could be isolated in a pure enough form. If cloning is successful, this could lead to a breakthrough in the study of the pathogenesis of this lung cancer of sheep.

Diseases caused by blood parasites

Although no official serodiagnostic service exists, serological tests are carried out in special cases. For example, it was found that one of five buffalo declared "clean" in Zimbabwe which were destined for import to the RSA, had antibodies against the *Theileria parva* group, which indicated a

possible carrier condition of *corridor disease*. It was recommended that import be prevented.

Good progress is being made in the search for a therapeutic but non-sterilising block treatment for *redwater vaccine* reactions and their possible effect on the immunity of treated animals. It is aimed especially at protecting high-risk animals against vaccine reactions and facilitating the immunisation process of large numbers of susceptible animals. An unexplained condition of under-developed spleens was the cause of abnormal mortalities as a result of redwater among 7-month-old calves after they were inoculated with redwater vaccine.

Ignorance concerning the use of the Onderstepoort redwater vaccine and of the way in which redwater remedies work, leads to confusion in practice. Some veterinarians even try to dissuade farmers from using the vaccine in endemic areas.

It was found that a "dead" vaccine against *Asiatic redwater*, derived from infected red blood cell cultures, provides only partial protection of relatively short duration and at this stage it has limited potential.

Cattle that have recovered from artificial infections of *corridor disease* in the laboratory can be identified as carriers by means of blood transfusions to susceptible cattle and serological testing of such cattle.

Rhipicephalus zambesiensis, formerly confusd with the common brown ear-tick, was confirmed in the laboratory as being a new vector of corridor disease.

Good progress is being made with *horse babesiosis*. Pure South African isolates of both *Babesia equi* and *Babesia caballi*, were obtained and are being used for preparing antigens for serological tests. The serological tests are already successfully used for an epidemiological study. *Rhipicephalus e. evertsi* was also identified for the first time as a vector of *B. caballi* and it will soon be possible to study the development of the parasite in the tick.

The effect of increasing the number of organisms per dose of elephant skin disease vaccine is now being investigated serologically. In association with the National Zoological Gardens an investigation is being made into the possible role that puffadders might play as final hosts in the life cycle of *Besnoitia* spp.

Heartwater research

Because of the economic importance of this disease much research time is now devoted to it on a multidisciplinary basis. The problem of shock with the *nymph suspension vaccine* which led to its withdrawal, was partly solved with centrifugation, but there are still stability problems. The vaccine will hopefully be issued again in the near future.

There are also still several problems concerning the existing serological tests for *Cowdria ruminantium*. The Elisa test utilizing antigen from tick or mouse material gives a high background and low specificity with sera from different parts of the country. Antigen prepared by means of centrifugation and affinity chromatography from tissue culture material gives better results.

As regards the epidemiology of the disease, a study undertaken on 23 farms in an endemic area showed that there is no relation between the incidence of *heartwater* and the immune status of animals as indicated by antibody titres. The immune status does increase with the tick load of the animals, and decreases with effective tick control. Even small numbers of bont ticks can, however, ensure effective protection of cattle against infection. Preliminary results indicate that the prostaglandin-forming processes are activated by heartwater infection and possibly play a role in the pathogenesis of the disease.

External parasites

Interesting results were obtained by the group that studies the propagation of *arboviruses* in *Culicoides* spp. For the first time efforts to infect Culicoides midges caught in the veld with *bluetongue* and *horse sickness viruses* in a field laboratory were successful. This is important because the different species that occur in different parts of the country can now be involved in experiments and not only those bred artificially at Onderstepoort.

Local surveys of *Culicoides* spp. were carried out at Allerton in Natal and in the Kruger National Park during the year under review, and after processing the results it is envisaged to carry out similar field studies at Stellenbosch and Middelburg since these areas differ drastically from one another and from Onderstepoort in the composition of their *Culicoides* populations. Attention is also paid to the seasonal and age distributions and the breeding grounds of the different midges.

Sweating sickness is caused by a toxin secreted by the bont-legged tick. Onderstepoort has toxic and non-toxic strains of this tick available, but only the females secrete the toxin and only during certain life stages. Trials showed that females weighing between 20 and 50 mg are the best source of the toxin.

Research on *Parafilaria bovicola* was concluded with trials in which the results obtained with 'Ivomec' treatment and regular spraying with deltamethrin (a pyrethroid insecticide) were compared. Both treatments dramatically reduced the number of lesions and regular spraying was very effective. There is, however, the problem that ticks may be eradicated to such an extent that immunity to tick-transmitted diseases is lost.

River midge (*Simulium*) control remains a problem. Further experiments with Teknar treatment of the Orange River at Augrabies were even less successful than previous treatments in the irrigation canals. Protection of sheep with ear tags was also unsuccessful. Manipulation of the water level, either by occlusion of the river or planned variation of the water level, still gives the best results.

Progress was also made with studies on resistance to ticks in the various cattle breeds. Preliminary results confirmed that indigenous Nguni breeds carry only a quarter of the number of ticks

found on European breeds, with cross-breeds somewhere between the two. Studies will continue to determine resistance in breeds and individuals, and efforts will also be made to identify the antigens concerned.

Internal parasites

Research in the Helminthology Section - which is seriously hampered by a shortage of personnel - is focussed on two problems, namely the increasing resistance of worms to existing anthelmintics and the survival of parasites under various conditions.

In collaboration with private firms two strains of *Haemonchus contortus* with pronounced resistance to the anthelmintic rafoxanide were identified. There is also a field strain of *Moniezia expanza* (of sheep) that is resistant to virtually all teniacides registered for use in sheep. True, only a few animals were used to prove resistance to all the remedies, but in the benzimidazole and resorantel groups undoubted resistance was found.

It has been proven that infectious larvae of the majority of the common gastric roundworms of sheep and cattle are definitely still infectious after being stored in liquid nitrogen for 9-11 years.

Development was as high as 71,4% in one-third of calves infested with *long-necked bankrupt worm* that had been kept frozen for 8,9 years. Results of infestation of animals were not yet available last year.

The survival of metacercaria (cysts) of liver fluke and giant liver fluke at 4-7 °C was also investigated. The infectiousness of liver fluke metacercaria remained more or less constant until the 48th week after collection, after which it gradually decreased. Infectivity was, however, still fairly high (30%) after a year. There was considerable variation in the case of giant liver fluke and this made it difficult to interpret results.

It was also shown that the *ova* of *liver fluke*, given *per os* to a horse, can move through the intestinal tract without losing their viability. This means that it would be possible to find cases of *pseudo infestation* in the field - where horses ingest liver fluke ova from the pasture and the ova might later be found in the dung. This could lead to the erroneous conclusion that the horse itself is infested while the ova may, in fact, have originated from infestation of sheep or cattle.

Liaison with the public

A total of 1 758 visitors in 86 groups were received by the Institute. Apart from this the liaison officer also handled 2 818 telephone calls during the year, had 242 interviews and wrote 94 letters. In addition about 364 000 specimens were received for analysis from local sources, and 1 500 from other countries.

VACCINE PRODUCTION AND DEVELOPMENT

Production

Because of strategic and economic considerations, the Veterinary Research Institute mainly produces vaccines for farm animals, while private firms obtain most of the vaccines used for pets and poultry from international companies. A total of 53 different vaccines, 10 diagnostic reagents and three therapeutic sera are manufactured by the Institute. About 10% of these are supplied direct to consumers, the rest being distributed by private firms on an agency basis. The table shows how vaccine sales progressed over the past 5 years. Since the record figures of 1981/82, there has been a steady decrease, probably due to the drought and economic conditions of the past few years. In 1985/86, however, there was a dramatic recovery to almost the level of 1981/82.

Vaccine sales in millions of doses

Year	Bacterial	Viral	Other	Total
1981/82	104,1	58,5	0,9	163,5
1982/83	104,9	46,4	0,7	152,0
1983/84	106,5	35,5	4,5	146,5
1984/85	97,8	28,4	3,4	129,6
1985/86	119,6	38,2	3,7	161,5

The biggest sales increase was in bacterial vaccines, e.g. *pulpy kidney* (an all-time record of 57 million doses), *blackleg, botulism, sheep pasteurella* and *haemophilus*. The increase in viral vaccines was mostly in *bluetongue* vaccine.

The low sales of *Rift Valley fever* vaccine give cause for concern since it dropped from 13 million doses in 1975/76 to below 1 million doses during the past year. Should a year of good rainfall occur, we could easily be faced with an epidemic because we now have a highly susceptible sheep and cattle population. It will be impossible for the factory to produce enough vaccine for a greatly increased demand in a short time.

Development

Efforts are continually made to improve existing vaccines and to find explanations for biological failures. At least 20 different aspects are being researched at present, some of the most important being:

- The development of skin reactions in sheep after use of *C. ovis* vaccine was largely solved by reducing the saponin concentration.
- The production of *C. pyogenes* vaccine was improved by preparing it in a fermenter and using a semi-synthetic medium.
- The use of Span 85 as emulsifying agent in the *E. coli* vaccine produced good results in respect of immunity, but after a second injection tremendous swellings occurred, especially in sows. The Institute therefore reverted to using Cirrasol.

- Good progress is being made with the refinement of sweating sickness antiserum.
- Trials are in progress to find a solution for problems encountered with the efficacy of the *Clostridium botulinum* type C component of the *botulism/blackleg* combination vaccine.
- The production method of *pasteurella* vaccine was modified and it is expected that the problem with the efficacy of certain components will be solved in this way.
- The efficacy of *pulpy kidney* vaccine was improved by preparing it on a semi-synthetic medium, and preparation costs were reduced by 50%.
- The immunity to *elephant skin disease* using a higher dose of parasites, remains very good after 13 months.
- Factors that influence the efficiency test for *rabies* vaccine in guinea-pigs were investigated and it was found that the use of adult guinea-pigs gives better results. The development of an oil-emulsion rabies vaccine for cattle was successful and a production batch is presently being prepared.
- The development of optimal culture media for three different vaccine strains of *Mycoplasma mycoides* was successfully completed and *lung-sickness vaccine* that complies with international standards is now available.

AGRICULTURAL RESOURCE DEVELOPMENT

RESOURCE RESEARCH

Land type surveys

A further two memoirs in the series on the natural agricultural resources of South Africa were published by the Soil and Irrigation Research Institute, bringing the total to five, while a further three are nearly ready for publication.

Twenty-one land type maps have already been printed and seven others are ready for printing. Five maps that have already been printed are being revised and the field work for a further 20 maps has either already been completed or has reached an advanced stage. Field work has been completed for 90% of the White parts of South Africa. A computerised land type data file, from which soil and terrain data can be withdrawn, is operational.

Peri-urban soil surveys

Semi-detailed soil suveys were continued in the Pretoria-Witwatersrand-Vereeniging (PWV) complex. The soil science information collected is made available to regional and urban planners with the object of identifying good agricultural land and retaining it for agriculture.

Soil surveys and investigations for irrigation

Reconnaissance and detailed soil surveys are carried out on proposed State and irrigation board schemes to ensure long-term success on the schemes. A total area of 149 500 ha was evaluated on a reconnaissance scale and 41 500 on a detailed scale.

Reasonably homogeneous farming areas and description of potential

The demarcation of reasonably homogeneous farming areas in the *Karoo Region* was finalised. Adapted stock types, current mean annual grazing capacity, recommended veld utilisation management priciples and veld burning practices were described for each of the 144 areas. The conservation committees made a considerable contribution to the finalisation of the demarcation of the grazing capacity zones and the acceptance of the grazing capacities by the farming communities.

The Lowveld Subregion of the *Transvaal Region* is in the process of identifying and mapping the high-potential soil in the area with the aid of the land type maps.

A technical communication on the agricultural potential of the magisterial districts in the *Highveld Region* in terms of dry-land crop cultivation and livestock production was published. For each of the 48 magisterial districts the expected long-term yields of the seven most important crops are given for all land types. Grazing capacities were determined for each reasonably homogeneous farming area within the magisterial districts and the livestock production potential is expressed in terms of large stock units. A crop pattern was also recommended for all the reasonably homogeneous farming areas within each magisterial district.

The *Winter Rainfall Region* divided the five subregions into 77 farming areas over the past year, while the resource use units within each farming area were described.

Demarcation of reasonably homogeneous farming areas in other Regions has been completed wherever land type maps have become available.

In the *Natal Region* the procedures for this purpose has been modified and refined. Good progress has been made in nothern Natal.

A useful farming handbook for a specific resource area in the *Eastern Cape Region*, the Uitenhage valley bushveld, was completed and made available to advisors and farmers. Similar handbooks are being prepared for other priority areas in the Eastern Cape.

Soil surveys with a view to farm planning

A report on the recently completed soil survey of the Dohne-Bolo area in the *Eastern-Cape*, covering 5 457 ha, was published and forms the basis for planning of the area.

In addition to this, soil surveys for planning purposes were also carried out on approximately 3 000 ha of land in the *Eastern Cape Region*. Approximately 900 ha was also classified in the Grahamstown area for run-off control planning.

Soil surveys for farm planning purposes were carried out on 3 073 ha in the *Winter Rainfall Region*. 2 263 profile investigations were carried out on 238 farms.

The farms of 61 members of study groups in the Highveld Region, with an area of 32 628 ha, were completely classified and provided with soil maps. These soil identifications were undertaken mainly by trained members of study groups on their own farms with the assistance of the Resources Section.

Soil fertility and plant nutrition

The volatilisation of nitrogen from commercial fertilisers applied to soils was studied in the laboratory of the Soil and Irrigation Research Institute and significant differences were observed. More than 70% of the nitrogen can volatilise from certain fertilisers. There is also a difference between

soils as regards the amount of nitrogen that is lost and the speed of conversion.

The KCl method of extraction for determining mineral nitrogen in South African soils was investigated and standardised. Soil analysis techniques are also refined using this programme to determine the mineral nitrogen in soils at the beginning of the growing season and to forecast the nitrogen yield of soils during the season. A unique turning platform was developed to test the hypothesis, using plants. With this method plants are exposed to conditions that imitate nature well.

During an investigation into the phosphorus status of cultivated soils in the South-Western Transvaal that had developed from two different adjoining matrices, the following was found under the same fertilising and crop cultivation practices:

- Red and yellow soils on granite have a higher phosphorus status than those that developed from lava.
- Where red and yellow soil on granite have approximately the same phosphorus status, it was found that on mixed matrices that include granite the phosphorus status of the red soils is significantly higher than that of yellow soils.

This investigation showed that matrices should be considered to make more useful recommendations regarding phosphorus fertilisation.

Research on the interaction of levels of N and P fertilisation in the cultivation of wheat on different soil types was begun in the Swartland and South Coast Subregions of the Winter Rainfall Region. Experimental soils were chosen to include a range of P and organic material contents from low to high, as well as different rainfall situations.

Yield reactions of wheat to N fertilisation were greatest where the rainfall was highest and where the organic material and therefore also the N content of the soil was lowest.

The reaction of subterranean clover to water soluble superphosphate and rock phosphate as P carriers and sources of residual P in the soil as well as top-dressing with the carriers was investigated in the Winter Rainfall Region. After three years of cultivation on residual P, it was found that rock phosphate can support the same yield as water soluble P.

The effect on water infiltration (and thus also on run-off) of applying gypsum to the soil was investigated on small experimental plots in the Winter Rainfall Region. Although not significant, there were slight indications that gypsum promotes both the infiltration of water and yields of wheat.

Soil chemistry

In an investigation by the Soil and Irrigation Research Institute into the active components of the Bray 2 and AMBIC extraction components, the importance of the different functional components was determined. The theoretical formulation was tested on aluminium, iron and calcium phosphate compounds by comparing the Bray 2 and AMBIC extractions. This formulation was used to explain the differences between the two methods of extraction in part.

Methods of analysis were developed for phosphorous and silica determinations. The perturbation effect of fluoride in phosphorous determinations was eliminated by making use of aluminium solutions that eliminate fluoride perturbations. The system of analysis was also adapted in such a way that phosphorus can be determined in the presence of high concentrations of strontium and calcium.

In an investigation into the effect of the application of sewage on the chemical composition of soils attention is being given to the possible accumulation and movement of heavy metals, other cations, phosphorus, nitrate and nitrite in soils.

In laboratory investigations in the *Winter Rainfall Region* strong indications were found that strontium chloride solutions can be used to determine extractable cations and acid in the soil. Using these methods for routine analyses contains possibilities for considerable cost-effectiveness benefits.

Nine means of and procedures for extraction were compared with one another in the *Winter Rainfall Region* to determine soil K. The most important of these were citronic acid, Bray 1, Bray 2, Isfei (Ambic) and ammonium acetate. All the methods correlated well with one another. Only in analyses of less than 50 mg per kg of K was the correspondence between the methods not always good.

Soil Mineralogy

A study of the morphological, physical and mineralo-chemical properties of a slope sequence in the Witfontein area near George, in order to determine their genesis, has been completed and published in the form of an M.Sc. thesis. The pedogenic accumulations of Fe and Al in these horizons were also studied in detail. There is evidence that these profiles have undergone recent podzolisation processes, varying in extent from one profile to another, as well as past (fossil) pedogenic processes.

The preliminary investigation into the composition and structure of reverse osmosis foulant deposits formed from the demineralisation at the Rand Water Board water has been completed in collaboration with the CSIR. The major constituents of these foulant deposits include finely divided organic material, poorly crystalline aluminium silicates and quartz, which are deposited from suspension and form an orientated interwoven matt of colloids and organic material parallel to the membrane surface. In some instances calcite forms and crystal growth continues on the membrane surfaces. The effectiveness of some cleaning solutions was investigated.

Soil Physics

The initial phase of work on the *in situ* genesis of silt size material has been completed. This work, applied to available data, indicated that, genetically, the upper limit of the silt-size fraction is probably around 50-100 μm rather than the 20 μm limit used by the international soil particle size classification system.

Water quality and pollution

A large number of *ad hoc* investigations into the disposal of effluent were carried out in terms of the Water Act, on behalf of the Department of Water Affairs. Vigilance testing of soil on which saline sodium effluent is sprayed confirmed that highly weathered red soils exhibit a great stability against the dispersive effect that sodium generally has on soil. It was also found that, owing to the soil's high affinity for calcium, the sodium accumulates deeper than expected in the soil. In spite of high percentages of exchangeable sodium, the soil remains acidic to neutral.

The availability to plants of the phosphorus in sewage and inorganic fertiliser when it is applied to soil that fixes phosphate showed that the phosphorous in the sewage is more available to plants because it is released slowly from the organic form and is taken up immediately. This effect was only temporary, however, and in an exhaustion trial both sources of P has the same final effect.

The large volumes of sludge, the high concentrations of potentially toxic elements and health risks remain the greatest hindrances in the large-scale use of sewage in agriculture.

Water utilisation

A joint research project with Israel in which the infiltration and other hydraulic characteristics of soil are being studied was continued. In this investigation use is being made of a rainfall simulator in which all the characteristics of rain (raindrop energy, saltlessness and different intensities) are simulated as closely as possible.

It is generally found that the salinity of water plays a large role in the formation of surface crusts with reduced infiltration.

The effect of the different cations normally found in soil and the behaviour of red soils in respect of crust formation are being investigated more intensively in separate studies. A better understanding of the factors that play a role is expected to make it possible to increase infiltration under both dry-land and irrigation conditions and thereby to improve water utilisation.

In a field trial in the *Highveld Region* it was found after two years that the use of a stubble mulch on turf considerably improved ground water conservation, especially in the early growing season. This resulted in yields of grain sorghum increasing by more than five times.

Soil-plant-atmosphere-water relationships

It is now possible to improve the water consumption effectiveness of wheat by increasing the frequency of irrigation without changing the quantity of water applied. The best criterion that can be used for irrigation scheduling is the leaf water potential. A technique has been developed in which the angle that the leaf blade makes with the leaf stalk is used in irrigation scheduling for soya beans.

Agricultural meteorology

Progress was made with the development of a method of characterising droughts for purposes of monitoring. A method was also developed for natural veld to express the soil moisture content during the current season as a possibility in respect of the "normal" condition. It was found that the Ceres maize model has the ability, depending on the planting date of the maize, to give a good indication as early as the end of January or February of expected yield by using the so-called median year concept. The spatial distribution of the risk factors related to Angora goat farming were charted in accordance with the frequency of the incidence of weather conditions that could cause the death of the goats.

A computer program was developed in the *Winter Rainfall Region* for doing rainfall interpretations for any area in the Region. This technique can be used to draw maps to any scale for any part of the area with the available computer plotter.

Remote sensing

The Remote Sensing Division has had complete image processing facilities since the beginning of 1986 and is now able to carry out certain independent research.

During the period under review the focus was mainly on the training of staff and the identification of projects. The planning of three projects to investigate the value of remote sensing techniques in soil, natural plant growth and crop mapping was completed. A barley mapping project is being undertaken in the Rûens (Caledon, Bredasdorp and Swellendam region) for the Maize Board.

Vegetation

In accordance with the National Grazing Strategy, a revised grazing capacity map has been drawn up for *Natal*. The process of refinement is still on-going.

All Regions have given earnest attention to the important aspect of resource assessment and are currently engaged in identifying priorities for research.

Veld condition assessment on individual farms is being undertaken in all parts of the country.

SOIL CONSERVATION

Farm planning

During the year under review 37 new farms were planned in the *Eastern Cape Region* and 265 farms were replanned. This reflects an increase of 32,5% over the previous year. This increase can be ascribed mainly to the 16 farm planning programmes begun in 1985. During the year 1 124 conservation works at a subsidy value of R745 145 were approved. This represents an increase of 44,6% over the previous year.

In the *Eastern Cape Region* 380,5 km of contours were surveyed, offering protection to approximately 2 046 ha of lands. 120,7 km of contours have been completed under the subsidy scheme. A total of 54,6 km of drainage canals were measured up during the year under review.

During the year 3 115 ha were withdrawn from cultivation in the *Eastern Cape Region*, while 2 225 ha were established under permanent crops. Many of these withdrawals were as a result of the highly erodible nature of the soils.

The increase in respect of replanning and supplementary planning amounted to approximately 30% in the north-western parts of the *Free State Region*, i.e. Griqualand West, Bechuanaland and Gordonia, while planning in the rest of the Region remained constant. It therefore appears that the falling trend of the past few years has now reached a turning point.

The continuing drought and poor economic condition of farmers had a retarding effect on the protection of lands against floodwaters in the *Free State Region*. None the less, there was an increase of about 57% in the provisional surveys of protection works and of 22% in the completion of contour systems.

The total subsidy on conservation works amounted to R1,33 million over R1,10 million the previous year. The increased amount is mainly attributed to an increase from R94 366 to R307 000 in respect of bush control.

Wind erosion is a major problem in the *Free State Region*. It is also not a slow process, as is incorrectly accepted. The wind fills run-off channels with debris or they become so blocked with sand that the flow of flood-waters is obstructed. Public roads have had to be closed to traffic over the past year. Bulldozers are used to push sandbars back where they accumulate against roads.

The drought of the past few years has had a negative effect on the erection of soil conservation works, especially in the western parts of the *Highveld Region*. In contrast, the demand for surveys and the erection of conservation structures has increased considerably in the eastern areas.

Overall run-off control planning for single farm units once again made good progress. There was a significant increase over the 1984/85 season in the number of water courses and contours surveyed and designed in the Region.

A total subsidy of R957 506 was paid out the past year on conservation works of which 90% was in respect of water courses and contours and 10% in respect of stock watering and fencing.

A particularly high demand for conservation works was noticed in the *Winter Rainfall* Region. This is probably the result of greater conservation awareness among farmers owing to a renewed persuasion campaign in the form of a series of successful farmers' days on conservation over the past three to four years.

During the year under review soil conservation works to the value of almost R2,23 million were approved. This is more than ever before in the existence of the Region. Waterways accounted for more than one-third of the total value. Waterways and contour banks together accounted for almost 57% of the subsidy value of all approved works in the Winter Rainfall Region. This underlines the fact that the mechanical protection of cultivated land is still the main aim of soil conservation works in the Region.

There was also a sharp increase in the demand for underground drainage systems in the Region and the R500 000 mark was exceeded for the first time. Although ridge and furrow drainage systems to the value of R250 000 were approved under the subsidy scheme, many more of these were planned and executed by the farmers without the technical help of the Department and without financial assistance (subsidies).

Over the past year soil conservation works with a subsidy value of almost R1,26 million have been completed in the Winter Rainfall Region. The achievement of the year previously reviewed (1984/85), namely that more soil conservation works were completed and subsidised here than in any other Region, will probably be repeated for the current year.

A large number of requests with regard to the ploughing of new land, but particularly the burning of veld, were received during the year under review in the Winter Rainfall Region. There were a few cases of veld being burnt and new land ploughed without the necessary permission, but in terms of surface area these were insignificant.

Research

In the *North-Western Karoo* the state of erosion of soils is determined to identify problem areas for mechanical reclamation. The survey has already been completed on 80% of the Region's area of 12,5 million ha.

An investigation is being carried out in the *Free State Region* into the functional effectiveness of different types of smaller erosion structures in washed-away areas, dongas and ditches.

In the *Eastern Cape Region* soil losses associated with various mulch applications on pineapple ridges up and down the slope have been studied. 14 sites have already been tested and it has

become obvious that mulch at a rate of 30-40 tons/ha can reduce the soil losses through erosion by up to 9 times.

After the first year of observation it has been established that the erosion on newly planted pineapple ridges on contour on a Glen Rosa Kanonkop soil which was subjected to minimum tillage was negligible, despite the fact that a rainfall of 1 440 mm was experienced.

The maximum safe fall in and length of contours and planting ridges on pineapple land layouts associated with different cultivation practices over a full growing cycle were determined in order to establish the best protective measures.

Results obtained during the first six months already indicated that an application of 40 tons/ha of whole plants or 25 tons/ha of mulch will reduce soil losses from bare ridges from 32 tons/ha to 2 tons/ha. Further results show that losses in a ridge with a fall of 4% are 13 times greater than those with a fall of 1% and a 9% fall 46 times greater.

In the Alexandria district in the *Eastern Cape Region* the soil losses on land subjected to bush clearing have been studied in order to ascertain the safest cultivation practices on newly cleared soils. The sites were subjected to ripping on the contour and cultivating to seed-bed condition. The results so far indicate that soil losses on the section ripped across the slope on contour are four times less than on soil cultivated to seed-bed condition and that those plots with a mulch left on them are also erosion resistant.

Soil loss research in *Natal*, in collaboration with the Directorate of Agricultural Engineering, led to the production of a manual on the use of the Universal Soil Loss Equation for Natal Region. This is the first Region to apply the equation to design a conservation system on cropland for any given set of physical and agronomic factors.

WEED CONTROL

Good progress has been made in the Winter Rainfall Region with the control of weeds. The *Sesbania* snout-beetle (*Trichapion latriventre*) has been released by officers of the Region in a further six localities, namely in the vicinity of the Olifants River at Clanwilliam and of Trawal near Vredendal, as well as at Villiersdorp. Particularly promising results have already been achieved with this snout-beetle in the vicinities of Piketberg and Drew, along the Breede River, where flower development has already been so affected that no flowers or pods occur over large parts of the *Sesbania*-infested area.

With regard to the control of nassella tuft grass (*Stipa trichotoma*), all the farmers in the Swellendam area have co-operated well. Nassella has been effectively controlled where there were dense stands. It seems that there was also less germination as a result of the dry winter in the area. According to estimates, the infestion has decreased by 20% in comparison with the previous year. Nassella tuft grass infestation on the Groote Schuur Estate has decreased considerably and is estimated to be 10% less than the previous year. Unfortunately there are still certain areas in the vicinity where nassella occurs in abundance. In the Gordon's Bay area nassella infestation also causes problems.

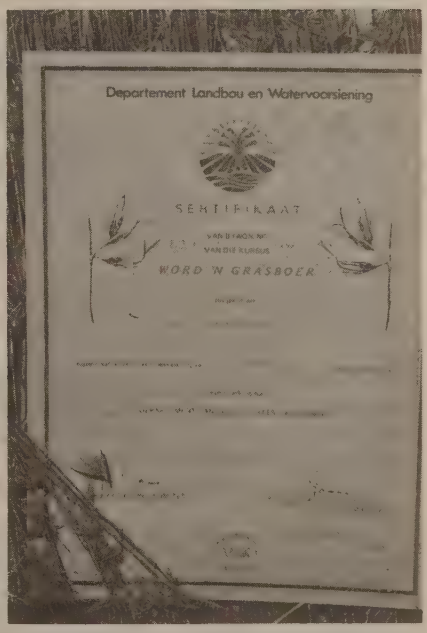
A programme for the control of the declared weed, jointed cactus (*Opuntia aurantiaca*), is under way in the Zeerust Extension Ward, *Transvaal Region*. Approximately 700 ha of land is infested with this weed. The programme is aimed at increasing the efficiency of control methods and eradicating the infestation in the district or bringing it under control. The extermination of other *Opuntia* spp. is also receiving attention and in 13 cases where *O imbricata, O ficus-indica, O stricta* or *O lindheimeri* occur spray has been provided and definite progress is being made.

The combating of invader bush in the *Free State Region* is at present limited to the Bechuanaland Subregion. Great progress has been made with the combating of bush over the past year. The number of applications for bush combating, for example, increased from 108 to 146 in the course of the year for a total area of 51 233 ha. The greatest problem with the combating of bush is the high cost of chemical agents.

An information centre to orientate smaller groups of visitors in respect of the Winter Rainfall Region's objectives and functions was equipped during the year under review and is regularly used

Old man saltbush, *Atriplex numularia*, is playing an increasingly important role as a drought resistant fodder crop in the north-western areas of the Winter Rainfall Region

Control of invader bushes in the Molopo area of the Free State Region. Bush encroachment remains a serious problem in this area



The certificate awarded to farmers who attended a grass-farming course in the Brandfort District of the Free State Region

ENTREPRENEUR DEVELOPMENT

PROGRAMMED EXTENSION

Since 1982 the Department of Agriculture and Water Supply has made every effort to formalise programmed extension. From this emerged the National Extension Strategy.

Purposeful long-term training of farmers by establishing and maintaining permanent and continuing opportunities for training and educating permanent audiences in the whole-farm concept are some of the basic principles of this strategy.

With the introduction of the National Grazing Strategy in 1984, this meant that the whole-farm approach in extension accepted the natural grazing as point of departure. It is from this point of departure that it is hoped to realise optimum resource use in the long term.

Highveld Region

At present there are 57 active study groups in the Highveld, most of which function as both field husbandry and pasture study groups.

The study groups, consisting of 711 members altogether, held 320 meetings this year attended by a total of 3 549 members. As many as 577 lectures and discussion sessions were offered on matters of topical interest to those concerned with field husbandry and pasturage.

Eight soil classification courses were offered for 108 study group members. The courses were concerned mainly with soil classification, the re-classification of land units, the choice of suitable crops and fertilising according to yield potential.

As a result of the oppressive drought, together with bad grazing management practices, the veld grazing in the Region is in poor condition. During the past year study groups particularly emphasised optimal grazing and stock management practices, and the National Grazing Strategy Programme enjoyed priority where possible. A grazing situation determination was carried out by questionnaire among 253 farmers.

Karoo Region

The regional agricultural development programme and four programmes for the subregions have been drawn up and serve as a basis for programmed information to co-ordinate and direct all agricultural development campaigns as much as possible.

Four subprojects, the themes of which are the group camp approach to grazing utilisation, the planting and utilisation of drought fodder crops, the application of scientifically tested stock management practices and efforts to change the attitudes of people who are thought to be contravening the Soil Conservation Act, are already under way. The persuasion programmes, of which there are more than 30, follow the principles of the National Extension Strategy to a large extent and are aimed at achieving the goals of the National Grazing Strategy as effectively as possible.

In the North-Eastern Karoo Subregion 40 farmers were persuaded to adopt the group camp approach and 645 ha of old man saltbush and 55 ha of spineless prickly pear were established.

In the North-Western Karoo a campaign was launched to persuade farmers to adopt and apply the new grazing capacities. The stocking rate in the subregion is at present estimated at 10% less than the prescribed long-term grazing capacity. This is the lowest stocking rate in many years.

Two situation determinations were also carried out in the subregion during the year under review. These surveys show that farmers in the North-Western Karoo have a sound approach to conservation farming.

The implementation of an extension programme to persuade farmers to apply the group camp approach in veld management has commenced in the Subregion. Already four permanent audience groups, with a membership of 44, have been established in the Kenhardt Ward. Plant survey plots were laid out on the farms of all members.

In order to enlighten the general farming community on grazing ground and veld management and to motivate them to optimal utilisation, mini field days are arranged.

The disaster drought that prevailed in the North-Western Karoo hindered the planting of drought crops.

The interest shown in the establishment of *old man saltbush* was satisfactory, however, and up to 71% of the farmers in the Carnavon and Williston districts intend to establish old man saltbush. Five permanent audience groups with the cultivation of drought fodder crops as their focus of attention have been established. At least 30 farmers started core plantings during the year and approximately 250 ha were established.

The integration of goats in the farming system of the North-Western Karoo is being propagated by means of extension. The purpose of the programme is to promote optimal resource utilisation. Farmers are especially being encouraged to farm with Angora goats. Despite limiting factors the number of Angora goats has increased from 8 400 in 1981 to 55 000 in 1986. An extension programme persuading farmers to apply optimal small stock management is being planned for 1986/87. In order to achieve this, four permanent bodies have already been established in the Kenhardt Extension Ward.

Natal Region

The implementation of the National Grazing Strategy in Natal was accepted as a challenge. Three target areas were identified and all extension programmes were modified as far as possible. It is hoped that combining the National Extension Strategy with the Natal Grazing Strategy will achieve the necessary improvement to the veld.

Taking the number of field days, short courses and study group meetings held in Natal as an indication of the progress made with the National Grazing Strategy, it can be concluded that a good start has been made with the promotion of veld improvement.

To enable *beef* farmers in North-Eastern Natal to improve their managerial abilities, a beef course is being presented to farmers of the Bayala and Magudu areas in the form of a number of single days held separately in each area at intervals of approximately two months. Each day deals with matters which are topical for the time of year. Most days have been attended by more than 50% of the farmers who are concerned with beef production.

A major problem in the sourveld areas of Natal is the high cost of production resulting from the very high overwintering costs. Theoretical exercises have indicated less costly, more profitable alternatives. These, however, require verification. A computer program was used to formulate rations for beef producers in the Ixopo area.

The development of the *Cedara Dairy Rationing* program (CEDARA) is continued and this program is now widely used from Cape Town, even to Benin, and farmers are saving up to R1 200 per week on herds of 200 cows because the program is preventing the overfeeding of protein.

Although maize is the main crop in Natal, second to sugar-cane, attention is given to other crops as well, e.g. economic wheat/soya bean production. In the *Ixopo* area farmers have shown a new interest in tobacco production and yields of 1,5 tons per ha were harvested.

The FERTREC program was modified during 1985 to include the Hunter system of analysis. A full publication on the system was published in March 1986. This advisory service to crop farmers is well used, as indicated by 14 975 soil samples analysed for farmers alone.

Conservation tillage techniques are becoming more popular in the Natal Region. In the Eshowe Extension Ward alone 2 500 - 3 000 ha of sugar-cane lands were programmed according to a minimum tillage system after one demonstration.

Eastern Cape Region

Following good rains in the past season it was proved beyond doubt that the extension efforts of the last two decades have favourably influenced the farming practices of the farmers in the district and that the natural resources, in particular the soil and vegetation, are in a better condition and less vulnerable to erosion than was the case earlier immediately after the years of drought. Progress, albeit slow, long-term progress, has also been made, as is reflected in the increased protection and more sensible utilisation of the source vegetation. The Dohne Sourveld area received 150-200% or more of its annual rainfall, which led to excellent recovery of the veld. In a recent veld condition determination it was found that the *Themeda triandra* count on a farm in the area had increased fivefold. The same trend was observed in the sweetveld areas of Queenstown.

A strenuous effort with grazing strategy as its theme has been initiated to focus attention on veld condition, stocking rate, grazing capacity and veld management practices. In most cases farmers are co-operating well.

In the Queenstown Extension Ward a programme is under way to persuade farmers to utilise grazing to the optimum and to promote animal production. Many farmers' associations are taking part in the programme.

Sheep and cattle group breeders continue to make good progress in the breeding of adapted stock types that are capable of increased production and reproduction under local conditions.

Owing to the very good prices that mohair is fetching at present in relation to other livestock products, farmers are increasing Angora numbers on a large scale. This is causing concern, however, since some of the areas are not traditionally Angora areas. Conversely, cattle are paying relatively badly, and some farmers are therefore now selling their beef herds and replacing them with Angora flocks, which leads to the large stock:small stock ratio becoming very unsatisfactory. In the most extreme cases veld is now being utilised only by small stock.

An increase in maize cultivation under irrigation has been observed in the Aliwal North Ward. Various cultivar and fertilisation trials are being carried out and very good yields are being obtained.

On plots of one ha each 14,92 tons have been obtained and yields of up to 17,92 tons on smaller experimental plots. A practice that is enjoying a great deal of attention is the minimum-tillage system, but high implement costs are slowing the change-over.

The buying out of pineapple farms for the consolidation of Ciskei led to expansion of the pineapple industry. The strict application of the area guide-lines and the area prescriptions for the East London and Komga districts regarding the working of land has ensured that these new developments take place in an orderly fashion and that land lay-outs conform to Departmental specifications.

Transvaal Region

Although high priority was given to *ad hoc* advice in accordance with the National Extension Strategy in the Silverton Extension Ward, attention is now increasingly being given to group campaigns through programming. Study group campaigns in three extension wards centre on peach cultivation,

milk production, the study of artificial pastures and beef production from veld grazing.

Owing to the lack of a community structure in the form of conservation committees, study groups and development committees in the Western Transvaal Subregion, the attention over the past four years has been focused on establishing permanent audience groups of this sort and training them for the role they should play. Good progress has been made in this regard.

In order to initiate grazing control in the extension wards of Zeerust, Rustenburg, Swartruggens and Thabazimbi, a situation determination was carried out by five conservation committees in the various conservation areas in the North-Western Transvaal. With this data as a point of reference, five grazing control programmes will be started in the extension wards concerned.

From a situation determination in the South-Eastern Transvaal it is clear that farmers see no economic advantages in better grazing and better grazing management. Under these circumstances it is unrealistic to expect spectacular results from the National Grazing Strategy. In co-operation with the agricultural development committees of Volksrust and Amersfoort it was decided that the advantages of better veld management should be demonstrated to farmers in practical ways especially with regard to wintering practices.

In the South-Eastern Transvaal a beef herd competition is being held which can be broadly regarded as an informal learning group aimed at improving management practices. According to the cattle expert at a co-operative that has been involved in this for the past four years, progress is clearly noticeable. Approximately 12 farmers are participating and only commercial herds are judged.

Two young ewe flock competitions were held at Amersfoort and Volksrust in co-operation with the NWGA and they were combined with a farmers' day. This served as an excellent discussion forum. It is also intended to exploit these occasions as an opportunity for launching the communication programme.

Free State Region

During the year 31 programmes were implemented that are directly concerned with the improvement of natural pastures, and that thus link up with the objectives of the National Grazing Strategy. In the Mid-Free State Subregion the improvement of natural pastures and the planting of perennial grazing is being promoted by the implementation of nine programmes. In the extension wards of Brandfort and Theunissen a course on veld management was offered and a total of 80 farmers qualified for the certificate issued on completion of the course. Farmers were also persuaded to undertake radical veld improvement, which was particularly successful, since marked veld improvement was observed on bare spots.

It is noteworthy that farmers took the lead during gatherings of the permanent audience groups in pointing out incorrect veld boundaries and suggesting corrective measures. The principle of veld-type boundaries was fully accepted by the farmers concerned.

Courses in veld management were also offered in the Bloemfontein Extension Ward. These contributed to, amongst other things, a positive attitude towards veld management and increased the knowledge that farmers have of pasture plants from 41% to 73%. A good start was made on radical veld improvement and with the planting of perennial pastures.

In the Bechuanaland Subregion a lot of attention is being given to the control of invader plants and the improvement of natural pasture. Situation determinations in the various wards show that in some areas up to 78% of pasturage is subject to bush encroachment. It was further found that there are shortcomings in the application of veld management and that many farmers overestimate the grazing capacity of the veld. In the Griqualand West Subregion the improvement of the natural pastures was aided by the implementation of 10 extension programmes.

The extent of the oppressive drought seriously hindered the extension campaigns in the Gordonia Subregion. Grazing capacities were finalised and mapped out on a farm-to-farm basis in co-operation with the conservation committees. A mail-in record study group consisting of 26 members was established. A course on veld management and Angora goat farming was attended by 214 farmers.

The advancement of farming in the Vaalharts irrigation area is being achieved by means of the practical demonstration of irrigation practices on a demonstration unit. The results of the demonstration project are supplied to farmers continually during interviews and farm visits.

During the year under review 45 extension programmes were drawn up in the Free State Region with the promotion of stock and game farming as the objective. Each of these programmes was drawn up on the basis of the National Extension Strategy and with the whole-farm approach as starting point. Ten extension officers were involved in the establishment of the programmes.

Winter Rainfall Region

The main objective during the year under review was to establish programmed extension in the Winter Rainfall Region. Aspects that are receiving attention are, in order of importance-

- establishment techniques for long-term crops
- establishment and utilisation of drought-resistant crops
- improvement of pasture
- improved small-grain production techniques
- improved management systems and techniques for dairy and sheep farming
- inclusion of lupin as a rotational crop
- research into table grape block competition

In the Boland Subregion three farmers' study groups held 13 group discussions and two field days,

with an attendance of 280. Seventeen information meetings also took place here on wine grapes, table grapes, onions and summer vine development, with a total attendance figure of 572. In addition to this, two soil courses attracted 50 participants.

In the Wellington Extension Ward co-operative demonstrations were carried out on 21 grasses and clovers under dryland conditions in the Agter-Paarl area and on six different lucerne cultivars in order to evaluate hay yield under irrigation.

Inspections of small-grain cultivar and grazing trials were attended by about 262 farmers in 12 localities in the Swartland Subregion. Four short courses on the fertilisation of small grain were also offered in this subregion and attended by 135 farmers and 14 representatives of other bodies. The annual farmers' day at Langgewens was attended by 370 interested parties.

At Piketberg, Malmesbury and Darling three mini young ewe flock competitions were held in which 89 farmers participated, while the judging was attended by 207 farmers.

In the North-Western Subregion three competitions were held for farmers on the identification of grazing plants and their order of preference with regard to palatability. This method aroused great interest and 142 farmers took part. Three field days were presented for 120 farmers on grazing management and six lectures on the same topic were presented at farmers' association meetings. The topic was also dealt with at meetings of conservation and programme-planning committees. A slide series was compiled on the topic and shown to farmers and farms were visited in connection with extension on veld management.

The production survey among 450 stock farmers in the North-Western Subregion to determine the relationship between stocking rate and production per SSU as well as per unit of area has been continued. The results of this survey over the past three years show that a lower stocking rate than that currently being applied by farmers gives a higher production not only per SSU but also per unit of area.

A survey was carried out amongst 45 farmers in the Hardeveld area with regard to the establishment of drought-resistant fodder crops in the Vredendal Extension Ward. A collaborator was found in every area to plant 5-10 ha of old man saltbush for demonstration purposes. A cheap planter for planting old man saltbush was designed and introduced to farmers.

Seven *Merino flock competitions* were held with 124 participants in the South Coast Subregion while three dairy herd competitions were held with 31 competitors.

Three irrigation clinics were held at Caledon (total attendance 45), two soil days at George (attendance 38) and one soil day at Swellendam (attendance 13). Mulch cultivation was discussed. An information day on fungus control in wheat was held at Riversdale, attended by approximately 180 farmers.

In the Riversdale Extension Ward a research and extension campaign was initiated in the Duineveld farming area. Leading farmers in this area established a study group during the year under review in order to bring problems to the attention of the Department and by so doing to obtain solutions and recommendations about them.

TRAINING

Agricultural college training is offered for prospective farmers at five agricultural colleges of the Department of Agriculture and Water Supply, namely Cedara (Natal Region), Elsenburg (Winter Rainfall Region), Glen (Free State Region), Grootfontein (Karoo Region) and Potchefstroom (Highveld Region). Table 1 shows the student numbers at the various colleges.

TABLE 1 - Student figures at Agricultural colleges in 1984/85 and 1985/86

	1984/85	1985/86
Cedara	124	123
Elsenburg	183	184
Glen	133	137
Grootfontein	102	107
Potchefstroom	144	144

In addition to the formal diploma course the colleges also offer a variety of short courses. The total number of courses offered and the total attendance figures are given in Table 2.

TABLE 2 - Number of short courses offered by colleges and attendance

	Number	Attendance
Cedara	10	193
Elsenburg	7	154
Glen	16	253
Potchefstroom	24	620

At Potchefstroom the total attendance figure of 477 students last year increased to 620 students, but the attendance of the milk production course fell considerably. Last year the average attendance was 36 per course, as against 15 this year. Interest in the short courses on sheep increased significantly this year, and attendance almost doubled. There was a reasonable increase in the attendance of the grain grading courses.

AGRICULTURAL INFORMATION

Popular publications

During the year under review 102 new and revised leaflets were published in various series, and about 250 leaflets were reprinted unchanged. A further 66 information documents on animal husbandry in the summer rainfall area were also published and distributed.

A total of 114 issues of newsletters were edited and prepared for printing. In addition 104 Agricultural Reports of the foreign offices were

printed here. A further 81 publications appeared as reports, manuals, lectures and technical bulletins. Departmental organisations were also continuously advised on compiling and planning programmes, newsletters, brochures and special publications.

Scientific publications

Articles - During the year under review 49 articles were received - 2 less than the previous year.

Together with 42 articles left over from the previous year the editorial committee dealt with 91 articles. Of these 69 were approved, 16 are still being considered, 4 were cancelled and 2 were rejected.

Of the 69 approved articles, 43 were published, while 26 are being carried forward. The year under review therefore ended with a carry-over of 26 approved articles and 16 that are still being dealt with.

Onderstepoort Journal of Veterinary Research - The following editions appeared during the year under review: Volume 52 (2), (3) and (4) and Volume 53 (1) in which 44 contributions were published.

Other scientific publications - The following scientific publications appeared during the year under review: Technical Communications No. 197, 198, 199, 200, 201, 202, 203, 204; Flowerings Plants of Africa Vol. 48, parts 3 and 4; Bothalia Vol. 15, 3 and 4; Flora of Southern Africa Vol. 31 (1); Memoirs of the Botanical Survey of South Africa No. 52, 54, 55; Entomology Memoirs No. 61, 62, 63, 64, 65; Memoirs of the Natural Agricultural Resources of South Africa No. 3 and 6; Agricultural Research 1985.

News service

During the year under review much prominence was given to the National Grazing Strategy. This was done by publishing reports in *Agricultural News*, broadcasting over *Calling All Farmers* and by means of special press releases that were extensively used by the media.

Special efforts by the news personnel to bring the Department's achievements and activities of the Minister to the attention of the media were also very successful. A new field with tremendous scope, is the early morning agricultural television programme. Several hints and ideas were channelled to this important medium, with good results.

The regular weekly publication, *Agricultural News*, was also increasingly quoted by the media.

Calling All Farmers

A major change took place during the year in that, with the reorganisation of the SABC programme setup, the broadcast time was changed at the beginning of 1986 from 06h00 to 05h30 and the duration shortened to allow for commercial breaks before and after the programme.

The main emphasis during the year remained the promotion of the National Grazing Strategy, soil conservation and the advancement of better farming by means of talks and interviews with agricultural research workers, agricultural economists and farmers concerning improved techniques. Departmental extension services in the regions were consulted at all times so that material broadcast corresponded as closely as possible with local development programmes.

Measures to be taken to overcome the effects of the drought and financial aid to farmers, the strengthening of the border areas and the devastating locust plague, were dealt with while close links were also maintained with agricultural research institutes, marketing boards, organised agriculture and the various nature conservation authorities.

Several series were broadcast covering, inter alia, stubble mulch and no-till soil preparation, sea life and the environment, animal science as a career, the Veterinary Faculty at Medunsa, the private veterinarian at work, protea production, citrus research, cultural aspects of S.A. farming and cholesterol.

Audio-visual services

Slide series - Fifteen new slide series were compiled during the year under review. These include some multi-vision programmes on the major agricultural industries and a persuasion programme in support of the National Grazing Strategy. Programmes on some 200 topics are now available to agricultural extension officers and the many institutions that use the slide series for educational purposes.

Following the official policy of maintaining good relations with independent states and South Africa's neighbouring states, the Division of Audio-visual Services, at the request of SARCCUS, compiled a slide series for Lesotho on the skinning and processing of skins and hides. Delegates from several of these countries were also advised on the production of audio-visual programmes.

A total of 625 duplicate sets of slide series were loaned to various institutions during the year under review, and 45 are on permanent loan to departmental institutions.

More than 1 500 colour slides were loaned to individuals and private institutions during the year.

Video productions - All the slide programmes will soon be transferred to video tape and be available on VHS and Beta cassettes.

It is planned to create facilities for the production and editing of video material of professional quality for extension and training, and for use by the SABC.

Documentation Centre

The services rendered by SADAL to researchers and extension officers during the year under review stabilised still further in many respects. Although no specific introductory campaigns aimed

at private institutions were launched, the current private user number increased from 50 to 70. This sector includes users from other state departments, boards, universities (and students), co-operatives, technical associations, commercial marketing institutions etc.

CAB data base

SDI-service - By means of the Department's selective dissemination of information service, 102 400 documents were retrieved for researchers and extension officers during the year. This represents an average of 8 530 documents per month. The 600 participants increased to 750 during the year, and although the average number of documents retrieved per profile increased from 56 to 67, the percentage relevance was exceptionally high.

Retrospective service - With only the CAB data base complete available to the Centre, more than 400 researchers/extension officers could this year be supplied with very valuable scientific information. The CAB data base now has 1,792 million documents that are available to researchers by means of retrospective retrieval. During the year about 78 000 document references were supplied to 406 users/enquirers - a retrospective retrieval of an average 192 documents per person compared with last year's 194.

Some 180 400 documents were therefore retrieved from the CAB data base alone, and mailed to users.

FSTA and VITIS data bases

Towards the end of the year under review the complete series of data bases were received from Germany (Food Science Technology Abstracts and Viticultural and Enological abstracts). The complete series consist of magnetic tapes with machine legible information from 1969. About 10 users for an SDI service and 80 retrospective retrievals have already been accepted on an *ad hoc* basis, and completed.

Agricultural libraries

The joint stock of the Central Agricultural Library and its 21 branches constitutes an important source of reference for the country as a whole and for the branch libraries mutually. The stock includes 141 000 books, 10 400 current journal titles, 221 300 pamphlets and 113 800 state publications.

The task of the libraries is reflected in replies to 46 400 reference queries, the circulation of 98 000 journals to officers and 11 600 inter-library loan requests received. The libraries also requested 9 300 inter-library loans from other institutions.

Two libraries, the Central Agricultural Library and the library of the Botanical Research Institute linked up with the computerised South African Bibliographical and Information Network (SABINET).

The publications AGROLIBRI, the acquisition list of the agricultural libraries and the house journal LANDBOUBIBLIOTEKE/AGRICULTURAL LIBRARIES, are dealt with by the Central Agricultural Library.

The library personnel act as liaison officers between the local officers and SADAL.

AGRICULTURAL ENGINEERING SERVICES

Agricultural implements

Tractors - The development of a scientific model for predicting tractor performance was completed. The model includes a technique for simulating performance during transportation. The performance of a number of locally developed tractors was measured and the manufacturers were advised of the results.

Tillage implements - The research on chisel plough tines was expanded with the development of techniques for measuring the effect of soil forces on tines. Deductions can be made from the results in respect of the specific energy consumption with different tine and share configurations.

Research was done to determine the effect of specific cultivation practices on moisture penetration and conservation on heavy turf soils of the Springbok Flats. In the Winter Rainfall Region the ripping patterns using different chisel plough tine configurations were investigated and further research is being done to determine the appropriateness of different tillage systems and, in particular, different planting methods.

Equipment for basin cultivation was developed and tested on the land.

Planters - The research on single-kernel planters was completed and further investigations were carried out into the effect of certain seed treatments on planter performance. The performance of a number of vegetable seed planters was also investigated.

Spraying equipment - Research was carried out to determine the resistance of different nozzle materials to wear and tear. A study was also started to determine the performance of orchard sprayers in terms of volume, drop sizes and air flow.

Soil-wearing parts - Research on the resistance to wear and breakage of different materials and heat treatment processes continued in co-operation with local manufacturers.

Horticultural mechanisation - A study on the present level of mechanisation in horticultural production was completed and certain fields of research were identified. Research on the causes of mechanical damage to potatoes was begun, as was development work in relation to vegetable harvesting equipment.

Agricultural structures and related facilities

Dairies and dairying equipment - As part of the official evaluation programme on milking

machinery, a mail-in questionnaire was sent to about 5 000 dairy farmers and approximately 37% have returned them. Field tests were carried out with 90 farmers and a further 30 farmers have still to be visited. A study of labour effectiveness in milking parlours is being done together with this project. Development and field evaluation of a composite neck clamp-foot raiser were completed and detailed plants compiled. A large number of dairy farmers were given advice in the form of standard plans, specific plans and visits to offices and farms. 22 lectures were given on these subjects.

Beef-cattle housing - A project on the planning of auction pens for 3 000 head of cattle and 200 sheep was completed. The plans contained general guide-lines for the design and are now being issued as standard plans. Lectures on cattle handling were given at a beef-cattle short course. A publication on the housing of beef cattle was compiled and released.

Dealing with animal waste - Siphon cisterns were developed and successfully tested in pig and dairy-cattle housing systems. The development and construction of cisterns with disk-ploughshare outlet valves is continuing. An improved manure separator was built and is at present being practically evaluated. Lagoon-type manure dams are already very popular and are built by farmers in most cases as manure handling and treatment systems. Guide-line plans have been made available for this purpose. The development and evaluation of composting techniques for animal waste are continuing.

Facilities for sheep farming - An experimental round sheep dip with an inlet chute at a tangent has been erected and is now being evaluated. Standard plans for three-point, four-point, five-point and six-point chute shearing sheds and for crescent-shaped shearing shed complexes on the New Zealand pattern for three-points and six-points were drawn up. A shearing shed, feeding pens and a handling system were planned for Boskop Training Centre. Similar planning was done for Botshabelo Shearing Training Centre. All the plans are made available as guide-line plans for general use.

Pig housing - A publication on pig farming for maximum feed utilisation and improved profitability was released. Research is being done on improved and cheaper maternity crates. The planning and design of a 100-sow demonstration unit for Bainesfield Estate Training Centre were completed and building has begun. Two models for the opening and closing of windows for pig housing were built as demonstration units for agricultural extension purposes.

Animal feed processing - Various hammermills, crushers, pelleting machines and roller mills were evaluated. Research work in respect of the grinding, mixing and pelleting of certain rations was done for the Nooitgedacht Research Station and for the ADSRI in Irene. Standard plans for feed processing facilities for feeding-pens and dairy complexes are being drawn up as general guide-line plans.

Climate-controlled structures and facilities - The idea of one emergency air-conditioning unit per greenhouse has now being accepted. Each new air-conditioning unit is provided with a wall socket and air passages that can be easily linked up. If an air-conditioning unit should fail, it can easily be removed and replaced with the emergency unit. This gives the establishment more time for repair work without the trial being negatively affected.

A unique insectarium that works on a 100% fresh-air system was developed for the Vegetable and Ornamental Plant Research Institute at Roodeplaat. Contaminated air is sucked away direct and does not come into contact with the researcher. Researchers experienced an allergy problem caused by beetles, etc. This has also now been eliminated.

Biological control of invader plants using pathogens required a unique quarantine greenhouse. An extractor fan with ultra-fine filters that causes a negative pressure to counteract the escape of pathogens was used.

Grain silos - The Directorate of Agricultural Engineering and Water Supply was involved in technical advising and checking on the following grain storage projects during the year under review:

- Construction of nine new grain silos with a total storage capacity of 480 000 m^3
- Extensions to six existing silos to enlarge the storage capacity by 155 200 m^3
- Installation of driers in nine existing silos.
- Installation of aeration equipment and temperature monitors.

These projects will represent an estimated cost of R52,65 million on completion.

Guide-lines were also drawn up for the installation of aeration equipment and temperature monitors, and the silo tubes of the co-operatives in the Winter Rainfall Region that store and handle barley were equipped with this apparatus.

Research on agricultural energy

Sunflower oil as fuel - Approximately 5 000 hours have been logged for two tractors doing normal farm work and using a mixture of sunflower ester and diesel without experiencing any fuel-related problems.

Research for a suitable additive for use in pure sunflower oil as fuel for tractors was continued and promising results were obtained with an additive developed by a local firm.

Solar energy - A number of mechanical problems were experienced with the locally developed solar windmill, which was erected for evaluation at the Soutpan Experimental Farm. Adjustments were made and it is expected that the unit will function well from now on.

Hydro energy - Existing equipment became inadequate for further turbine development and improved facilities were designed.

Wind energy - Equipment for performance tests on complete windmill heads was built and is working satisfactorily. A study evaluating different windmill heads is continuing.

Irrigation and drainage engineering

Evaluation of irrigation equipment - The hydraulics laboratory has been expanded and automated to make it possible to investigate various types of irrigation equipment. Investigations of sprinklers, filters, drippers and hydraulic valves were carried out. Various studies were done to help manufacturers with the development or improvement of their equipment.

Irrigation courses - Practical irrigation courses continued to be presented to farmers, representatives of irrigation firms, designers of irrigation systems and extension staff. Courses on the design of underground drainage systems were also presented to engineers and technicians. The measurement of the infiltration capacity of soils in the design of centre pivots was demonstrated and explained to consultants and firms on various occasions.

The design of irrigation systems - Guide-line planning of irrigation systems was done for various farmers and the technical checking of designs for subsidy recommendations was dealt with. A number of irrigation designs for experimental farms was completed for the Department of Agriculture and Water Supply.

International symposium - Staff of the Directorate involved in irrigation and drainage presented four papers and nine posters at the International Symposium on Agricultural Engineering in Pretoria in January 1986.

Soil conservation engineering

Rainfall simulator studies - Research results obtained using rainfall simulators on cultivated lands proved the applicability of overseas results to South Africa in respect of the cultivation of soil, mulching practices and soil erodibility.

The advantages of various conservation practices in respect of the control of soil losses were evaluated and comprehensively demonstrated on farms throughout the country.

Technical control - Guide-lines and on-site guidance were given to the seven agricultural regions, especially in respect of the planning and checking of water run-off control and other soil conservation measures on farms. Approximately 6 000 works at a capital value of R11,5 million were dealt with during the year under review.

Key soil conservation works - During the year under review three exploratory reports were drawn up on the state of conservation in catchment areas and recommendations were made on where key soil conservation works should be erected in washed-away watercourses. 18 structures and 20 km of drainage canals were planned and designed as a result of the reports.

In spite of measures that had to be applied as a result of the curtailing of funds and to bridge the tremendous rise in the prices of machinery parts and building materials, work was still done by the construction teams as reflected in the accompanying table.

Teams erected a further 84 km of fences for the fencing off of washed-away watercourses and constructed 8 km of drainage canals. This work was done in the Highveld, Free State, Eastern Cape and Karoo Regions.

Electrical and electronic engineering

The Directorate has its own section that provides electronic and electrical services to the different divisions of the Directorate and to various bodies under the Department. The demand for the services of this section increased to such an extent that the number of staff members had to be considerably increased.

Farming development

There was a great deal of interest in the publications of the Directorate of Agricultural Engineering and Water Supply - to the extent that 40 354 copies of engineering publications were dispatched to readers. Of these, 11 527 were test reports on tractors, agricultural implements and related equipment. The Directorate also published its first newsletter during the year under review and this evoked great interest throughout the country.

GOVERNMENT WATER SCHEMES AND WATER DRILLING SERVICES

Irrigation engineering services and irrigation boards

The Department of Agriculture and Water Supply is now responsible for the technical administration of the subsidy scheme for irrigation works that was previously handled by the Department of Water Affairs. The Directorate is also functionally responsible for the management of the irrigation boards from a technical and economic

Existing structures repaired				New structures erected			
Under construction		Completed		Under construction		Completed	
Number	Value	Number	Value	Number	Value	Number	Value
3	R96 000	11	R199 800	8	R433 100	21	R648 330

point of view, while policy matters arising from the Water Act are co-ordinated.

There are at present 240 irrigation boards with a total scheduled area of 297 550 ha. One new irrigation board, Boschberg, was proclaimed and the establishment of four proposed irrigation boards is being dealt with. A total of 11 loans for waterworks to a value of R3,4 million was granted, involving eight irrigation boards.

To ensure that these duties are performed, a regional engineer has now been placed in each of the seven regions. After initial uncertainty regarding the transfer of the responsibilities, matters are now being successfully dealt with in co-operation with the Department of Water Affairs and relatively few complaints are being received from farmers.

Water drilling services

After the Department of Water Affairs had been in charge of the Government water drilling services for more than 60 years, the service was taken over by the Department of Agriculture and Water Supply in April 1985. This service provides drilling to agriculture and in some cases also to Government departments throughout the country in respect of boreholes for domestic and animal drinking water.

The service is subsidised and is held in high regard by the farming community for the excellent quality of work done. During the year under review 1 867 boreholes were drilled, representing a total drilling depth of 152 358 m and a daily water supply of approximately 200 000 m^3.

BOTANICAL AND PASTURE RESEARCH

BOTANICAL RESEARCH

Good progress has been made with research and the publications of the Institute reflect this very clearly. Nevertheless there is a steady erosion of available research funds. The unfilled research posts now constitute nearly 11% of the total; a situation which may be partially responsible for a drop in the total number of individual research papers published this year. The production of journals has, however, remained very stable and the publication of two memoirs, one volume of *Palaeoflora* and one volume and two parts of volumes of *Flora of Southern Africa* is remarkable progress under present circumstances.

The increasing demand for botanical information and plant identifications is reflected in the 28 000 plant identifications done last year. This has, however, meant that most of the professional staff in the herbarium have not had any time for research. In spite of an increase in demand for plant identifications of approximately 100% over a period of 20 years, which has been met by increasing efficiency, the herbarium staff complement has not been expanded and an intolerable situation has arisen where demands can no longer be met effectively.

Plant taxa

Flora of Southern Africa - Four fascicles were published: Xyridaceae, Juncaceae and related families; Crassulaceae; Lamiaceae; and part of Rubiaceae. Two fascicles are in press: Pteridophyta (ferns); and Burseraceae, Meliaceae and related families. Two fascicles are with the editor: the second part of Bryophyta (mosses) and part of Asteraceae. A number of genera in the families Poaceae, Restionaceae, Liliaceae, Orchidaceae, Salicaceae, Fabaceae, Ericaceae and Acanthaceae were completed and will be published when the rest of their respective fascicles are ready.

Palaeoflora of Southern Africa - The *Prodromus of Southern African Megafloras* was published. This volume gives an overview of the fossil plants that grew in southern Africa during Devonian to lower Cretaceous times (400 million years ago to 100 million years ago), while Africa was part of the supercontinent Pangaea.

PRECIS computerised information system - The *List of Species of Southern African Plants*, Edn 2, Part 1, listing synonyms and literature for cryptogams and monocotyledons was published and work is well advanced for Edn 2, Part 2, covering dicotyledons. Analysis of the 24 000 taxa in the PRECIS taxon datafiles shows that southern Africa has the most species-rich flora in the world. The PRECIS specimen database now contains 615 000 specimens and is the largest database of its kind.

Scanning electron microscope - 1 968 micrographs were prepared for various Botanical Research Institute and outside workers. These include *Ehrharta* leaf surfaces, lemmas of Panicoideae and *Digitaria*, Cucurbitaceae fruit and seed surfaces, *Vigna* inflorescence and leaf surfaces, lichen thalli, *Riccia* spores and thalli, *Euphorbia* leaf and seed surfaces and fern spores.

Comparative grass leaf anatomy - The leaf anatomy of the genus *Panicum* was dealt with in detail. It was shown that taxa belonging to the four different photosynthetic groups also shared other anatomical characters not related to photosynthetic anatomy. Within each of these four subdivisions several groups of species were recognised which shared similar anatomy. The anatomical variation in *Panicum* is great yet within this genus many groups of species can be recognised using anatomical criteria. The anatomy of several of these groups is more similar to that of other panicoid genera, such as *Oplismenus, Brachiaria, Urochloa* and *Eriochloa*, than it is to other species in *Panicum*. Taxonomically, *Panicum* is an exceptionally difficult group, but leaf anatomy appears to suggest some solutions.

Cytogenetics of grasses - Good progress has been made with this new research project and 275 species of 115 genera have already been collected in the field and transplanted in Pretoria. Good progress has been made with the determinations of chromosome numbers for many taxa, the panicoid and chloridoid subfamilies in particular.

Vegetation

Transvaal bushveld and forest studies - The area designated for research on the vegetation ecology of Sour Bushveld in the Transvaal Waterberg was stratified for sampling efficiency. A scale-related, vegetation-enhanced satellite-imagery method was developed for this purpose and should be of great interest for determining spatial patterns of vegetation and environment. Predictive expressions of species-area relation were established for determining subsample size.

The study of the vegetation ecology and environment in the Sabie area was successfully completed. These results, together with follow-up work, are being prepared for publication.

Coastal studies - Manuscripts on the dune vegetation between Richards Bay and the Mlalazi Lagoon and on the dry coastal ecosystems of the East Coast of South Africa were finalised for publication. A report on the vegetation of the Mzingazi Lake was prepared for the CSIR. Detailed research planning for the study of the coastal-dune

area between Kosi Bay and Sodwana has been finalised.

The vegetation data from in and around the estuaries entering False Bay were analysed. Three aquatic and semi-aquatic and 15 terrestrial communities were recognised on the basis of floristics. Alien vegetation and recreational, residential and industrial areas have increased in this area, whereas open sand and natural vegetation have decreased.

Cape fynbos studies - The text of the classification and description of the western coastal lowland fynbos is being finalised for publication. Final editing in respect of, *inter alia*, the nomenclature of plant species is being attended to. All the maps have been completed and tables and photographs require finalising for publication quality.

Four transects for the sampling of the vegetation of the Langeberg have been selected. Field work has begun on the transect through the Boesmansbos Wilderness Area, Grootvadersbosch State Forest. To date 55 relevés have been sampled in Mountain Fynbos vegetation. A further 80-100 samples are envisaged to complete sampling of this transect, which will include relevés in the remnant Afromontane forest communities.

It has been found that seeds of several fynbos species show maximum germination at low temperature, which suggests that germination may be dependent on the cold, wet winter months, irrespective of the season of seed shedding. Under experimental conditions, lone seedlings of *Acacia saligna* do not significantly affect the growth of *Protea repens* seedlings when grown at close proximity and even at high densities.

One fynbos species that has been identified as particularly well-adapted to tolerate the environment created by dense stands of *A. saligna* is *Rhus laevigata* (dune taaibos). Rotavation of burned mountain fynbos land has been shown to increase soil surface reflectivity, lower soil temperature and increase soil moisture levels during the summer following rotavation, but to have no significant effect on the shoot extension of introduced *Protea cynaroides* and *P. repens*.

Karoo studies - Field research results obtained for various forms of Karoo plants have raised important hypotheses that relate reduction in leaf surface area, stomatal resistance and transpiration rate, xylem pressure potential and root system morphology to succulent and non-succulent plant forms. These relations are expected to lead to a significant improvement in understanding adaptation to water deficits in different plant forms in the Karoo.

Grassland studies - Detailed facet proposals for the ecological studies of the grassland vegetation of the Amersfoort area of the Eastern Transvaal Highveld have been drawn up and approved. Field sampling has begun. An aid to the vegetative identification of grasses in the Amersfoort area has been compiled to assist in the identification of grasses when they are not flowering.

Ecological bibliography - The *Ecological Bibliography and Thesaurus for Southern Africa up to 1975* has now been completed. It is to be published as *Memoirs of the Botanical Survey of South Africa* No. 52 and is due to appear in 1986. Work on the second volume for the period 1976 to 1986 is under way.

Ecological data bank - Steady progress is being made with the accession, storage and processing of vegetational and environmental data for the inventory of vegetational resources. Data are obtained for accession as hard copy in the form of unprocessed field data or in variously processed forms, including published or unpublished papers, reports and maps. The PHYTOTAB program package is used for the classification and ordination of data sets.

Valuable veld plants

Conservation of germ plasm - The following seed was included in the germ plasm bank: 569 collections of *Sorghum bicolor* subsp. *bicolor* and 764 collections of *Pennisetum africanum*. Primitive crop collections being held for potential breeding purposes now total 3 371.

Indigenous food plants - A further 180 species were added to the national food plant databank, bringing the total of species included to 1 589. Information was also added to the records of many species already listed. Information gathering on 14 priority food plants, mainly members of the Cucurbitaceae continued, with 30 more references being included. Observations on the shelf life of fruits and on associated fungi and insects were added.

Crop plants of African origin - A great deal of material of primitive cereal crops grown in the Caprivi and Kavango areas was collected, labelled and catalogued. The characteristics of 524 collections were analysed. A survey of crop frequency and preference was also extended to Caprivi and Kavango. All except three of the priority areas for primitive cereal crops in South Africa and South-West Africa have now being included in the survey and collecting programme.

Woody invaders - A popular version of the report on woody plant invaders of the Transvaal, with 16 colour illustrations, has been prepared for publication. It will enable laymen to identify the worst plant invaders and gives hints on their control.

National weed list - Preparation for publication of the expanded National Weed List, now titled *A Catalogue of Problem Plants in Southern Africa*, was completed. It provides basic information on 1 653 species and includes a list of 711 invasive alien species and a common name index incorporating more than 8 000 names. Its appearance is expected to stimulate the collection of a great deal more data.

Declared weeds and invader plants - A publication has been prepared to enable members of the public and law enforcement officers to identify the 47 species of declared weeds and 9 species of

Researchers at the Botanical Research Institute, Pretoria, examining wild melons and cucumbers for evaluation as food plants of economic potential

declared alien invader plants covered by the provisions of the Conservation of Agricultural Resources Act of 1983. It includes black and white illustrations, descriptions, a copy of the relevant legislation and advice on control.

Pretoria National Botanical Garden - New developments include: completion of most of the fencing and paving of the new eastern access road, three additional paths along the nature trail and a new borehole was brought into service. The living plant collection grew by 784 accessions (mostly for the Karoo biome) and 317 grass accessions for research purposes. Replanting of a shade house with rare and endangered species from Namaqualand and the Namib was completed and the Karoo koppie plantings were added to.

Research collections

Information - Plant specimens identified for officers of this Institute, State Departments, Provincial Administrations, universities, neighbouring states, overseas visitors and the general public numbered 28 015. Information was given to 2 036 visitors, 2 691 telephone enquiries were handled, 9 300 specimen exchanges were sent out and 10 525 specimens were loaned to other herbaria world-wide.

Computerisation of services - A Burroughs B25 multi-user computer network was purchased. This will be used as a management, curatorial and research aid. Applications are being prepared to handle plant identification and loan and exchange records and also to print specimen labels and to regulate selection of specimens accessed into the herbarium.

Determining priority collecting areas - Maps have been prepared, using data from the PRECIS databank, to show specimen and species collecting frequencies at the ¼ degree square level. A number of fairly well defined areas are identifiable which are poorly represented in collections in the National Herbarium.

Collecting grasses for the National Herbarium - Collecting was carried out in the Orange Free State and north-eastern Cape. 169 specimens representing 156 species were collected. In the case of both species and specimens the representation in the National Herbarium was increased by more than 1 500% for four of five ¼ degree squares sampled.

Publications

The following were published during the year: *Bothalia* 15, 3 and 4; *Flora of Southern Africa* 4, 2; 14; 28, 4; *Flowering Plants of Africa* 48, 3 and 4;

Memoirs of the Botanical Survey of South Africa Nos 50 and 51; *Palaeoflora of Southern Africa: Prodromus of South African Megafloras, Devonian to Lower Cretaceous.* Seventy-three articles by members of the staff were published.

GRAZING RESEARCH

Highveld Region

Veld grazing - A continuous improvement in the mass of heifers was obtained with veld grazing in a field trial at Potchefstroom over a period of four years. At the beginning of the covering season during the spring of 1982, veld heifers had reached an average mass of only 256 kg at an age of approximately 15 months. One year later, the next group of heifers had reached an average mass of 292 kg by the end of the winter; another year later, the next group of heifers at the same stage of development had already reached a mass of 306 kg and by the end of the winter of 1985 the next group had reached a mass of 340 kg.

In 1982 the average covering mass of the heifers was 418 kg at 27 months; it was 435 kg in 1983, 450 kg in 1984 and 490 kg by the spring of 1985 - an increase of 72 kg per heifer since 1982. The heifers covered in 1985 reached an average mass of 652 kg by the end of the summer and were 92% in calf, with condition score of 4,1 out of 5. Should this trend continue, consideration will be given to allowing veld heifers to be covered at an age of 14 months as is the case for the pen fed group.

The continuous improvement can be ascribed to some degree to genetic improvement, but mainly to the improved production of the veld. It was always attempted to make available to the animals sufficient roughage in the form of mature palatable grasses. The average protein content of the winter veld, for example, was 8,9% and the *in vitro* digestibility was 53,2%.

Rye-grass - From trials conducted on rye-grass over a year it is clear that the cultivar Billion thrives best in the southern and western parts of the highveld region. Billion has a higher phytomass production and a longer growth period than the very well-known Midmar cultivar. The value of the longer growth period lies in the fact that Billion experiences its peak production during the spring when there is usually a general food shortage in respect of dairy cows and intensive slaughter lamb production. The growth period can be extended even more by limiting the frequency of use from the peak production period to no more than a three week interval. This prevents seed formation and ensures that Billion can produce higher quality grazing until the middle of November.

Karoo Region

A study to determine the phytomass of plants in the 12 most important veld types in the Karoo was completed last year. The phyto mass and chemical composition of a total of 105 different plant species were determined at three-monthly intervals at 53 different locations covering 12 veld types. The information obtained helps to improve understanding of the feed flow in the Karoo.

Natal Region

Rye grass - Live mass gains in excess of 1 200 kg per ha have been recorded for beef weaners grazing on intensively managed Midmar Italian ryegrass. The value of a clover component in an Italian ryegrass pasture is reflected in increased daily gains per animal and in improved animal carcass grades. Irrespective of whether a pure grass pasture or a closer/grass pasture was used, it was found that there was a decline in performance per animal as the stocking rate was increased. However, with the inclusion of clover, improved animal performance was more marked at high than at low stocking rates. This improved performance at the high stocking rate, relative to the low stocking rate, is attributable to the development of a greater clover component.

Eastern Cape Region

High potential areas - The effect of the structure of grazing on milk production of animals and pastures is investigated. There are noticeable seasonal differences, but the most important fact is that a copious supply of grazing is essential for milk production.

Valley Bushveld - At present the research priorities in the Valley Bushveld is to develop a method to determine veld condition and grazing/browsing capacity. It has been established, that, although bushveld condition (in the Kirkwood and Uitenhage districts) is negatively related to the percentage of *Lycium austrinum*, it is positvely related to tree density, foliage volume below 1,5 m and the percentage of *Portulacaria afra, Euphorbia* spp. and *Schofia afra*. It has also been established that an abundance of *Azima tetracantha* is indicative of a bushveld subtype in the Kirkwood district, whereas an abundance of *Brachylaena illicifolia, Rhigozum obovatum* and *Zygophyllum margsana* is indicative of a Uitenhage subtype. The major difference between these subtypes is the nature of the relationships between density and total browseable volume. A technique was developed to score bushveld condition in the Uitenhage and Kirkwood districts and to serve as a model in the other bushveld subtypes.

Central Grassveld - Above average rainfall was experienced in the central grassveld areas of the region, but the veld condition has not recovered from the effects of the previous very dry years.

Good performance figures were again obtained from the demonstration farming system at Adelaide.

However, animal numbers have not as yet been increased to their pre-drought levels, allowing recovery of the grass. The condition of the browse has not as yet completely recovered and goat numbers are therefore being kept relatively low.

Field trials were conducted to determine the growth patterns of *Acacia karroo* plants under different conditions. *A. karroo* respond positively to defoliation by goats. The leaf production of the optimum defoliation level was of the order of 2 to 3 times that of undefoliated plants.

Acacia karroo plants rely on both reserves and increased photosynthesis to recover from defoliation. Reserves take at least a season to recover following defoliations of the order 70% or greater. Recovery following 25 or 50% defoliation takes place rapidly within the same season.

Goats will select *A. karroo* plant parts in preference to grass until approximately 50% defoliation of the *A. karroo* plants has taken place. Thereafter they select increasing amounts of grass. When 90% defoliation of the *A. karroo* plants has occurred only 30% of the grass has been consumed.

Free State

Drought characterisation - A model has been developed to simulate the veld production of the Glen region. This work has now been extended to all the fairly homogeneous farming areas of the region in an attempt to develop similar models for the various regions. The development of these models offers the possibility that droughts may be identified on a scientific basis, that veld production may be calculated on a daily basis, that grazing capacity may be determined down to farm level, and that the relationship between rainfall (climate), veld condition, veld production and grazing capacity may be investigated.

Bush control - In the Molopo area approximately 3 million ha of veld is experiencing serious bush invasion. In chemical bush control experiments it was found that *tebuthiuron* is an effective weed killer of most woody invader plants. It can be applied successfully from the air at levels as low as 1,5 kg/ha. An increase in grass production of up to 840 per cent, as compared with untreated sites, was obtained within two years.

Tebuthiuron currently seems to have no adverse ecological effects and may be regarded as a good substitute for 2,4,5-T, which has been banned world-wide because of the danger of dioxin poisoning.

In the arid regions of the Free State wild pomegranate has invaded more than 1,2 million ha, while the figure for South Africa as a whole runs to more than 4 million ha. Research in the Gordonia area has shown that grass production is reduced by 50-75 per cent as a result of wild pomegranate invasion. Intensive research is being continued in order to find effective control measures. Research during the past two years has shown that the snake berry (*Stoebe vulgaris*) and the wild pomegranate can be controlled effectively with tebuthiuron and ethidimuron.

Artificial pastures - An investigation was launched into the economic aspects of artificial pastures in dry-land conditions in the Free State. This showed that -

* it is not economically justified to plough veld in a good condition in order to introduce artificial pastures.
* under average and below average control it is not economical to replace crops on marginal fields with pastures instead, but dry-land lucerne, grazed by sheep and dairy cows, and sorghum pastures, grazed by dairy cows, appear to be an economical alternative.

Management and the strategic integration in the feed flow programme are of crucial importance for economically successful pasture grazing. Outlay could only be amortised after 12 years in the case of a weanling production system on veld and artificial grazing. Only sales of the seed of the grazing could provide for the economic success of the system.

A weanling production system run on *Cenchrus ciliaris* grazing according to recommended production practices realises lower gross margins than veld during an experimental period of 5 years. In contrast, a finishing experiment on one and two-year-old steers on *C. ciliaris* grazing produced considerably better gross margins than a weanling production system on veld and artificial grazing. The economic result of this was even better than that obtained with feed pens and maize and wheat production on similar soil.

Winter Rainfall Region

Artificial pastures - In a study of dry-land carrying capacity carried out on the Tygerhoek experimental farm it was found that the carrying capacity of lucerne pastures was approximately 6 merino ewes, and that of medic pastures approximately 5 merino ewes per ha. The wool and meat production was much higher on lucerne pastures than on medic pastures. On the basis of these results, lucerne is the most suitable crop for long-term pastures in the southern coastal area of the Winter Rainfall Region.

Weed control - In a study out of the Tygerhoek experimental farm the effect of different weed control strategies on the animal production potential of dry-land lucerne, medic pastures and subterranean clovers was investigated. It was found that low concentrations of herbicides resulted in an increase of wool and meat production, but that the difference decreases as the concentration is increased. The effectiveness of expensive chemical herbicides is thrown into doubt by these results.

Pasture quality - In carrying capacity studies under dryland conditions as well as under irrigation on the experimental farm Tygerhoek and Outeniqua it was found that, the higher the legume content of the pasture, the higher the wool and meat production per ha.

Forage crops - The results of tests to evaluate a variety of forage crops were used to develop production models of approximately 11 grasses and legume crops. These models can be used to predict the seasonal production of the crops at various places in the Winter Rainfall Region under dry-land and irrigation conditions, with only simple and readily available weather data as input. These models have since been combined in a more complex model which can be used to predict carrying capacity, animal production and gross income on a pasture and farm scale, once again using only weather data as input.

LEGUME RESEARCH

Natal Region

Clover - Inscription of Dusi, a new white clover variety developed at Cedara, on to the variety list provides for a clover variety which exhibits better drought resistance and better perenniality than other white clover varieties on the variety list. Although Dusi clover still needs to be more fully evaluated, this clover offers considerable potential for improving animal performance over a wider range of climatic conditions.

Winter Rainfall Region

Seed reserves in a medic/maize rotational cropping system - A survey was undertaken in March 1986 of the soil utilisation experiment at Langgewens in the Winter Rainfall Region to determine the amount of seed of medics (*Medicago truncatula* cv *Jemalong*) in the top five centimeters of soil on the various rotational cropping systems. The amount of seed that could potentially germinate was calculated for each system.

It was found that although the various systems differ from each other in respect of the amount of germinable seed in the soil, it was clear that enough seed was present in all systems to ensure a good crop for the next year. It can therefore be concluded that a poor resettlement of medic pastures cannot be ascribed to too low seed reserves, but rather to other factors.

Eastern Cape Region

In the Tsitsikamma and Bathurst areas in the Eastern Cape tests are being conducted on annual and perennial legumes to find types suitable for pastures. Problems are being experienced with the establishment of the tropical/subtropical legumes, although they thrive fairly well in the Bathurst and Humansdorp areas. The white clover types are generally vulnerable to droughts and warm winds.

The trials on annual and perennial legumes at Dohne are now being concluded. A threesome of perennial legumes (crown vetch, glycine and lucerne) have been identified as doing fairly well in the Dohne sourveld. The trial with annual temperature legumes indicated that these crops can be cultivated profitably only if a considerable amount of moisture is present during the winter months. Commercial cultivation of seed can be very profitable.

AGRICULTURAL FINANCE

Agricultural Credit Board

The activities of the Directorate of Financial Assistance are determined largely by the Agricultural Credit Board, which consists of a Chairman, a Vice-Chairman and ten members, who are appointed by the Minister of Agriculture and Water Supply.

The primary functions of the Board, which is an autonomous body, are to provide financial and other assistance to farmers and to make recommendations on the recovery of debts and matters pertaining to security for loans, subject to the directions of the Minister.

During the year under review the Board dealt with 7 185 cases.

Granting of assistance

As a result of emergency conditions and other negative economic factors it was not possible to accede to all the requests for financial assistance of the kind granted to farmers by the Agricultural Credit Board. Consequently certain schemes in terms of which financial assistance may be granted by the Agricultural Credit Board were suspended for an indefinite period with effect from 24 August 1984.

The schemes that were suspended were loans for the purchase of livestock and implements, waterworks, the sinking of boreholes, the eradication of invader bush, afforestation, the effecting of improvements, the construction of housing for farm labourers and the purchase of agricultural land. The assistance schemes under which it is still possible to apply for funds relate to the payment of debts (consolidation), production loans, emergency aid and soil conservation works.

The amounts granted by the Agricultural Credit Board during the year, and the number of loans and the number of rejected cases, are shown in Table 1 opposite each scheme.

The reasons for the discrepancy between actual expenditure and the amounts granted by the Board are the following:

- A considerable number of applications that had been approved by the Board had not yet been settled by 31 March 1985, and some payments were in respect of grants made by the Board during the previous year.
- Between 50% and 80% of the grants made by the Board for disaster aid represents a subsidy and do not form part of the loans.
- There were savings on or cancellations of assistance that had already been granted.

TABLE 1

Scheme	Granted		Number of applications rejected
	Number of loans	Amount R	
Purchase of means of crop production (seed, fertiliser, fuel, etc.)	2 651	96 115 891	566
Purchase of livestock	27	549 625	7
Purchase of farm implements/equipment	-	-	-
Construction of soil conservation works	64	1 565 224	1
Building of waterworks	1	1 29 100	2
Drilling	-	-	1
Control of bush encroachment	-	-	-
Purchase of agricultural land and grants of land	144	12 931 590	87
Making or repair of improvements	1	50 000	-
Installation of a power-line and electrical distribution network	-	-	-
Establishment and/or management of a private forest	-	-	-
Payment of farming debts, including mortgage debts	834	56 493 929	1 399
Housing for farm labourers - Coloureds, Greater Western Cape	2	17 000	-
Other population groups	-	-	-
Disaster aid Stock-feed scheme in scheduled grazing distress areas, including the transportation of drinking water for livestock	230*	48 082 078**	4
Flood relief scheme Boland, Karoo and Eastern Cape and areas affected by cyclone Domoina	2	62 505	-
Total	**3 956**	**215 896 942*** **	2 067

*Only new applications received
**Subsidies included
***Amount actually spent on loans, about R146 million (Does not include R0,588 million for the purchase of land and R0,771 million to ensure the security of the population.)

Granting of assistance in designated areas: Northern and North-Western Transvaal border area

During the year under review an area about 40 km wide adjoining the existing 10-km strip was also declared designated area. All the assistance schemes applicable in the 10-km strip except that for the purchase of agricultural land also applied in the wider strip.

In the light of the terrorist activities in the area an interest-free loan scheme was instituted for the purchase of radio transmitters as phase 1 in the

programme to ensure the security of farm residents in the entire 50-km wide strip. During the year under review 305 applications for such loans were approved and a total amount of R784 580 was paid out.

A scheme was introduced during the year in terms of which interest rates on the Land Bank loans of farmers who occupy their farming units within the area on a full-time basis are subsidised by the State for a period of 5 years so that they pay an effective rate of only 4%. During the past financial year an amount of R110 449 was paid over for this purpose in respect of 98 cases.

Because of the adverse economic climate a number of assistance schemes continued to be temporarily suspended. Table 2 contains a summary of the applications dealt with during the period 1 April 1985 to 31 March 1986.

TABLE 2

Number of applications considered	Applications approved	Type of assistance	Amount granted R
93	69	Means of crop production	1 553 111
154	85	Payment of debts	4 176 387
38	27	Livestock	613 850
99	21	Land purchases	5 712 000
0	0	Soil conservation works	-
384	202		12 055 348

The considerable difference between the number of applications for land purchases received and the number granted may be ascribed largely to the high land prices and to a lesser degree to the poor financial position and inadequate knowledge of farming of applicants. Of the 21 persons to whom loans were granted for the purchase of agricultural land, 9 came from outside the area and 3 were helped to obtain additional land in order to make existing uneconomic units more economic. The remaining 9 cases were people already living in the area but not owning any agricultural land.

State land

All State land which has been identified as suitable for agricultural purposes and in which no other Government department has an interest is handed over to the Department of Agriculture and Water Supply by the Department of Public Works and Land Affairs. It is the policy not to sell State land out of hand, but to give all interested persons the opportunity to compete for the acquisition of the land on an equal footing. This can be done in three ways, viz -

- by inviting applications
- by the sale of the land by public auction; or
- by calling for tenders.

The first method is applied in terms of the Agricultural Credit Act of 1966 and the last two in terms of the State Land Disposal Act of 1961.

If the land is offered to the public for sale by calling for applications, its availability is advertised on a country-wide basis in the case of an economic unit, but only locally in the case of an uneconomic unit, since the latter type of unit has to be combined with other adjacent agricultural land or land in the immediate vicinity. In both cases all applications received for the land in question are considered by the Board strictly on merit.

Sale by auction or tender takes place only in exceptional cases.

During the year under review 56 210 ha of agricultural land to the value of R5 807 447 was awarded to successful applicants. Along the Upper Orange River 16 properties with a total size of 3 927 ha were sold by public auction for a total of R4 545 000.

Short-term assistance

Crop production loans are of a continuous nature and may be granted in all the recognised field cropping areas of the country. Loans up to a maximum amount of R50 000 per calendar year are available for this purpose at present.

As a result of the severe drought of the past few years approval was granted for -

- the limit of R50 000 per calendar year in respect of production loans in the summer field cropping areas to be increased to R75 000 from 1 September 1984, and this concession has provisionally been extended to 31 August 1986;
- an interest subsidy of 2% on such loans to apply for the period of 12 months, i.e. from 1 September 1985 to 31 August 1986; and
- farmers in the summer field cropping areas who do not have the necessary means for the purpose and who cannot obtain the necessary credit elsewhere to use production loans partly for the payment of cash wages and maize meal rations to full-time farm labourers. This scheme will also apply for a period of 12 months, i.e. from 1 September 1985 to 31 August 1986.

Particulars in connection with applications for loans of this kind considered by the Board during the past 2 financial years are given in Table 3.

TABLE 3

Financial year and scheme	Applications considered Number	Amount	Average	Loans granted Number	Amount	Average
1984/85	3 055	121 691 794	39 834	2 661	87 552 282	32 902
1985/86	3 217	133 328 167	41 445	2 651	96 115 891	36 256

Long-term assistance

Table 4 gives particulars of applications considered by the Board during the past 2 years.

TABLE 4

Financial year and scheme	Applications considered Number	Amount R	Average R	Loans granted Number	Amount R	Average R
Land purchases						
1984/85	85	20 810 165	244 825	19	3 740 125	196 849
1985/86	101	35 924 841	355 691	22	4 761 300	216 423
Improvements						
1984/85	34	1 178 707	34 668	19	525 978	27 683
1985/86	1	60 000	60 000	1	50 000	50 000
Discharge of debts						
1984/85	1 658	262 173 560	158 126	787	46 576 115	59 182
1985/86	2 233	460 092 960	206 043	834	56 493 929	67 739
Soil conservation works						
1984/85	55	1 338 439	24 335	55	1 306 000	23 745
1985/86	65	1 690 523	26 008	64	1 565 224	24 457
Waterworks						
1984/85	127	8 051 521	63 398	88	5 064 713	57 554
1985/86	3	173 000	57 667	1	29 100	29 100
Housing for farm labourers						
1984/85	141	2 285 516	16 209	135	2 160 841	16 006
1985/86	2	17 000	8 500	2	17 000	8 500
Livestock						
1984/85	79	3 242 950	41 050	26	439 671	16 910
1985/86	34	1 760 400	51 776	27	549 625	20 356
Implements						
1984/85	20	741 125	37 056	4	93 830	23 457
1985/86	None	-	-	None	-	-

Drought assistance schemes

Since October 1985 good rains have fallen over virtually all the livestock grazing areas and the field cropping areas in the summer rainfall region, the exception being Gordonia and adjacent areas and a few other areas where follow-up rains unfortunately did not occur.

The Minister of Agriculture and Water Supply announced on 24 February 1986 that -

- all drought feed assistance was to be suspended on 31 March 1986;
- further drought assistance for livestock farmers would be considered in terms of the Livestock Grazing or Field Husbandry Schemes only in areas where it might still be justified in the light of objective norms; and
- the National Drought Committee would decide on the continuation of Phase 5 assistance in those exceptional cases where districts or parts of districts were still receiving Phase 5 assistance and had not yet had any effective rain by 1 April 1986 and where livestock were therefore still being fed continuously.

The assistance paid out in terms of the various schemes during the year under review declined as shown below in comparison with the period previously reviewed. This is attributable to the fact that the number of districts or parts of districts receiving emergency assistance declined from 122 on 31 March 1985 to 71 on 31 March 1986.

Table 5 contains particulars of the number of districts or parts of districts, by province, with the emergency assistance applicable on 31 March 1986.

Expenditure under the various schemes is set forth in Table 6 and compared with the figures for the previous financial year.

The increased payments in respect of the incentive may be attributed to the fact that more of the Phase 4 and Phase 5 areas switched to the new Phase 5 scheme, which entails a 50% livestock reduction and an incentive payment.

TABLE 5

Province	Phased scheme	Stock grazing scheme	Field husbandry scheme
Cape Province	19	5	-
Orange Free State	29	1	2
Transvaal	6	4	5
	54	**10**	**7**

TABLE 6

Schemes	Rebate	1984/85 Loan	Subsidy	Incentive
Total	**14 585 664**	**22 451 418**	**72 623 410**	**2 478 343**
Schemes	**Rebate**	**1985/86 Loan**	**Subsidy**	**Incentive**
Phased scheme	8 975 651	13 453 484	51 163 944	3 671 751
Stock grazing scheme	795 352	865 822	4 320 829	3 082 871
Field husbandry scheme	391 878	38 907	1 901 545	-
Total	**10 162 881**	**14 357 213**	**57 386 318**	**6 754 622**

Subsidisation of interest on carry-over debts and new production credit

The schemes approved during the previous financial year were extended for a further year. The carry-over debts with co-operatives of farmers in the summer field cropping areas were again consolidated on 1 September 1985 and can be redeemed over a period of six years. The interest rate is subsidised by the State so that farmers pay an effective rate of only 8% on carry-over debts. An interest subsidy of 35% is payable by the State on the Land Bank lending rate applying from time to time to cash credit loans to agricultural co-operatives for the provision of new production credit for the 1985/86 season for their members in the summer rainfall areas for a further period of one year. At present assistance in this regard at different rates and over different periods is also in effect for sugar cane, table grape and deciduous fruit producers. During the period under review R197 978 717 was paid over to the Land Bank, as against R125 902 145 the previous year.

Flood damage (Domoina)

The purpose of assistance under this scheme was to place farmers more or less in the same position as they were in before the flood. This assistance involved loans for the following purposes:

The actual cost of the repair and re-establishment of damaged irrigation land and dry land on which crops had been established at fixed rates applicable to the crop concerned;

the actual cost of the repair and replacement of damaged or destroyed waterworks and the actual cost of the repair and/or reconstruction of damaged or destroyed soil conservation works.

Loans were subsidised by 75% and farmers who did not avail themselves of the loans qualified for the 75% subsidy as soon as the work had been completed satisfactorily.

A 100% subsidy was also payable on land washed away completely or where reclamation was not considered economically justifiable.

Repairs began as soon as possible after the flood and were largely completed during the 1984/85 and 1985/86 financial years. Expenditure in this regard is set forth in Table 7.

In a few cases extension was granted so that repairs could be completed during the 1986/87 financial year.

TABLE 7

	1984/85	1985/86
Loans	450 353	431 850
75% subsidies	3 021 430	7 528 729
100% subsidies	2 218 149	629 520
Total	**5 689 932**	**8 590 099**

Water quota subsidies

This assistance scheme was introduced to enable farmers to remain on their farms until sufficient irrigation water (50% of the water quota) becomes available so that they can continue production. During the year under review an amount of R2 601 122 was paid out in respect of the various schemes, as set forth in Table 8:

TABLE 8

	1984/85	1985/86
Riet River	2 315 797	2 152 659
Kaffir River	-	197 415
Lindleyspoort	-	251 048
Total	**2 315 797**	**2 601 122**

Recoveries, deeds and estates

Registration of mortgages and issuing of deeds of grant - Owing to the fact that funds were limited and that certain assistance schemes were suspended, somewhat fewer mortgages were registered (1 465), whereas the subdivision of the pasture at Loskop North caused an increase in the number of deeds of grant registered (175). There are still many cases of renouncement and this also caused an increase in the number of documents registered (2 557). These cases continue to be dealt with as a matter or urgency since large amounts of money are involved in the payment of interest.

Consents and estates - There was a considerable increase in the number of documents of consent that were drawn up and registered in which consent was given in respect of restrictions registered against the title deeds of properties under section 35 of the Agricultural Credit Act, 1966 (Act 28 of 1966). Similarly there was also an increase in the claims proved against insolvent, deceased and agricultural credit estates. During the year under review 347 claims were proved, as against the 299 of the previous year.

Control over security - In order to protect the interests of the State great reliance was once again placed on the services of Departmental outdoor officers. For purposes of exercising control over security - and increasingly for attachment and liquidation - 531 special investigations were needed. 3 105 routine investigations were also carried out for the recovery of debt, entailing a total distance travelled of 477 631 km.

Recovery of debts - As during 1984/85 agriculture in general again experienced a poor year. Conditions deteriorated further, but it was nevertheless possible to recover approximately R77 million while numerous requests for extension were considered and approved. At the request of the Agricultural Credit Board, requests for extension for the repayment of crop production loans are also referred to the Board for consideration and a

recommendation. This procedure has become necessary on account of the protracted drought, which has obliged the Agricultural Credit Board to consider other forms of security, so that in some risky cases mortgages were even registered to cover arrear crop loan debt.

Outstanding debts - The amount owed by farmers in respect of financial assistance stood at R495 million at the end of 1984/85. This amount rose to R624 million at the end of the present year.

AGRICULTURAL PRODUCTION ECONOMICS

RESEARCH

The Directorate of Agricultural Production Economics continued or completed the following research projects in the field of economics:

Production factor studies

- An investigation into the determination of the value of agricultural land in the RSA.
- The determination of rentals and parameters for realistic rentals for agricultural land.

Structure studies

- The development of an alternative method for determining minimum farm sizes is receiving further attention.
- A study on cost/benefit analysis for investment decision-making with regard to agricultural development projects to be undertaken by the public sector is continuing.
- A study on market potential and price analysis for selected agricultural products for the cost/benefit analysis of resource development was started.
- *Ad hoc* research on the development and replanning of irrigation areas is continuing.
- Research on the financial rehabilitation of crop farmers with liquidity problems in the summer field cropping areas is being continued.
- A systems approach to decision-making analysis in irrigation farming was begun.
- An efficiency comparison of large and small farming enterprises and company and family enterprises in the Sundays River Valley, Eastern Cape, was undertaken.

Operating and production cost studies

Comprehensive operating and cost studies are undertaken annually on a rotational basis in one of the three chief maize-producing areas and in one of the three chief wheat-producing areas, with supplementary studies in the remaining areas. Production costs for several other branches of farming are calculated from these studies, including costs for sunflower seed and groundnuts.

Comprehensive production cost studies were undertaken for maize in the Western Transvaal and for wheat in the Eastern Free State.

Farm management techniques

With regard to the development of managerial aids and managerial information systems the following matters received attention:

- Further research on the refinement and expansion of the income and cost estimate system (COMBUD).
- Additional publicity for and the expansion of the Financial Record Book for Farmers.
- The design of a computerised financial records system based on the methods contained in the conventional Financial Record Book for Farmers.
- The development of a planning model for determining the optimum enterprise choice for farms in the Winter Rainfall Region.
- An investigation into the use of microcomputers at farm level.
- The development of a model for decision-making on the replacement of orchards in the winter-rainfall field cropping area.

Farm business economics with mail-in records as the source data

This is a continuous project which has been in progress for 20 years. The numbers of mail-in records collaborators who received analyses of their farms during the year under review (with numbers for the previous year in brackets) are as follows: Collaborators of the Directorate - 680 (693), divided into 100 (114) study groups; collaborators involved through co-operatives whose farming enterprises were analysed by the Directorate - 465 (443), divided into 28 (26) study groups. At present 210 (484) farmers are on the computerised *Transakplan 1 system*.

Income and cost estimates

The computerised income and cost estimates system (COMBUD) now contains 400 estimates. Of this number 70 are experimental estimates. These estimates were printed and distributed individually and in the form of volumes. The implement costs guide, which is published annually, was brought up to date.

Business relations

The Directorate worked on the following research projects in co-operation with technical researchers from the regions and the research institutes:

- The inclusion of perennial pasture crops in sheep production systems in the grassveld grazing area of the Free State Region.
- An economic study of business relations in respect of fresh milk production in the Natal Region.
- The economic evaluation of fodder crop utilisation with Merino sheep in the Fish River Valley.
- The economic evaluation of the potential of artificial pastures in respect of small stock in the eastern coastal areas of the Eastern Cape Region.
- The economic evaluation of development studies of components of the dry grass-bushveld pastures of the Eastern Cape Region.
- The development and evaluation of a profitable stock farming system for the Valley Bushveld of the Eastern Cape Region, both in very poor condition and in good condition.
- The development, management and evaluation of an adapted stock farming system at Campagna in the high-rainfall sourveld area of the Eastern Cape Region.
- The influence of various feeding strategies on the economic efficiency of beef cattle farming in the summer-rainfall field cropping area.
- Research on the economic benefits of mulch cultivation in the summer-rainfall field cropping areas of the Western Transvaal and the North-Western Free State.
- A comparison of profit margins for weaner calf, steer and ox production systems in the Northern Transvaal bushveld.
- The economic evaluation of milk and meat production from the Simmentaler on natural veld and *Cenchrus* dry land grazing on the Springbok Flats of the Transvaal.
- A strategy for continuing and renewing production from established citrus and subtropical fruit orchards in the bushveld area.
- The wintering of woolled sheep and other stock in the Northern Drakensberg pasture area.
- An economic analysis of dairy enterprises and their financial role within the farming structure of mixed farms in the summer-rainfall field cropping area.
- The evaluation of the profitability of irrigated artificial pastures for stock farming in the high-rainfall sourveld areas of Natal.

TRAINING AND ADVICE

Although the Directorate's primary task is research, an important contribution was again made in the form of training and advice.

Officers of the Directorate held 613 lectures and 128 practicals at the five colleges of agriculture. In the course of visits to and from farmers, at farmers' days during short courses and by replying to queries the Directorate renders an extensive advisory service on production economics in agriculture. For example, 70 lectures were delivered at farmers' days, at meetings of agricultural societies and during short courses.

SUPPORTING SERVICES

Biometric and datametric services

An advisory service covering a very wide spectrum is offered, viz. general biometrics, the planning of trials, electronics, linear programming, optimisation and econometrics. Veld, hothouse and laboratory experiments were also planned in conjunction with overseas researchers. The experimental data were analysed and interpreted. A shortage of biometricians is definitely a problem. Help was provided in the preparation of several scientific articles and members of staff also read papers. Regular contact was made with university lecturers. Assistance was rendered in the completion of 9 B.Sc.(Hons.), 45 M.Sc. and 12 Ph.D theses.

The Scientific Systems Section concentrated on the determination of the computer requirements of the various centres of the Department of Agriculture and Water Supply. The extension offices and experimental farms are being computerised according to a four-year plan. The acquisition of computer equipment and the standardisation of equipment with a view to integration with Government network systems received most attention. The linking of microcomputers and minicomputers with each other and with the main frame system is progressing well. The computerisation of the section on the Liquor Control Act of the Viticultural and Oenological Research Institute is nearly complete.

Datametricians are responsible for scientific programming and systems programming, the design and management of data bases and the installation and maintenance of hardware and software.

Assistance and in-service training are currently making high demands on staff now that microcomputers are being installed. Researchers are being trained to help themselves, in order that biometricians can spend more time on consultations and datametricians can spend more time on the development of computer software. The availability of statistical software on microcomputers has raised interest in, amongst others, multiple variable techniques. Considerably more time is also being spent on the biometric training of datametricians, with a view to improving communication between biometricians and data metricians.

Research by other institutions

Contract research at universities

Fifty-eight applications were received to have contract research done at universities. Only one of these applications was not approved.

The universities involved were those of the Orange Free State, Potchefstroom, Pretoria, Rhodes, Stellenbosch, Witwatersrand, Natal, Cape Town, the Rand Afrikaans University, Port Elizabeth, Fort Hare and the Medical University of Southern Africa.

The departmental institutions on whose behalf the projects were undertaken are: Natal Region (3), Eastern Cape Region (2), Transvaal Region (1), Winter Rainfall Region (3), Highveld Region (1) Summer Grain Centre (11), Small Grain Centre (7), Oleaginous and Protein-rich Seeds Centre (2), Plant Protection Research Institute (10), Soil and Irrigation Research Instititute (1), Botanical Research Institute (1), Citrus and Subtropical Fruit Research Institute (6), Vegetable and Ornamental Plant Research Institute (3), Veterinary Research Institute (5), Fruit and Fruit Technology Research Institute (1). Total number of projects: 57

Ad hoc research at universities

Eighty-five of the one hundred and twenty applications received, were approved.

The following applications were received from the various departments at universities:

Departments of Animal Anatomy and Physiology (2), Oenology (4), Biochemistry (11), Soil and Plant Nutrition (4), Agricultural Engineering (3), Pathology (1), Parisitology (3), Physiology, Pharmacology and Toxicology (5), Animal Husbandry (9), Zoology and Entomology (4), Chemistry (1), Biological Sciences (4), Microbiology and Plant Pathology (11), Animal Science (9), Agronomy and Pastures (3), Botany (13), Tick Research Unit (1), Horticulture (5), Physiology (1), Poultry Science (1), Plant Production (5), Mammals Research Institute (1), Soil Science (1), Genetics (4), Food Science (3), Crop Science (6), S.A. Institute for Agricultural Extension (1), Veterinary Public Health (1), Infectious Diseases (1), Theriogenology (2).

Foreign research fellows at universities

One application has been received from the University of Cape Town and one has been received from the University of Stellenbosch. Both applications were approved.

ORGANISATION AND FUNCTIONS OF THE DEPARTMENT

The Department of Agriculture and Water Supply has the responsibility of promoting optimum agricultural production and the welfare of the farmers in the White population group of the RSA. According to the Constitution the Department is specifically responsible for the following services and assistance measures:

- Agricultural development services, including research, advisory services and extension
- Training at colleges of agriculture
- Financial and other assistance to farmers or prospective farmers or for the promotion of agriculture
- Irrigation schemes
- Drilling for water for agricultural and local authority purposes
- Subsidising of drilling and water affairs for agriculture and local authority purposes
- Financial assistance in respect of water-works damaged by floods

To accomplish this task the Department consists of an Executive Directorate with the Head of the Department assisted by six chief directors who are responsible for the management functions of the Department. At the level of implementation, 24 institutions, each with a Director in charge, are responsible for the specialised functions.

EXECUTIVE DIRECTORATE

Agriculture Building, Beatrix Street, Private Bag X250, Pretoria 0001

Dr D.J. Agenbach: **Head of the Department**

Chief Directorate

Co-ordination

Dr A.J. Heyns: Chief Director

Agronomy

Dr W.P. Grobbelaar: Chief Director
Mr F.I. du Plooy: Agricultural Management Adviser

Horticulture

Dr G.S. Bredell: Chief Director
Dr J.J. du Toit: Senior Agricultural Management Adviser

Animal Production

Dr F.J. van der Merwe: Chief Director
Dr H.S. Hofmeyr: Senior Agricultural Management Adviser
Vacant: Senior Agricultural Management Adviser

Farming Development

Mr J.J. Bruwer: Chief Director
Dr A.J. Aucamp: Senior Agricultural Management Adviser (Pastures)
Mr G.W. Oosthuizen: Senior Agricultural Management Adviser (Irrigation)
Mr L.M. le Roux: Senior Agricultural Management Adviser (Extension and Training)
Vacant: Senior Agricultural Management Adviser (Natural Resources)
Mr D. Grossman: Agricultural Management Adviser (Game Farming)

Auxiliary Services

Mr H.F. van Zyl: Chief Director

Specialised Research Institutes

Soil and Irrigation Research Institute
600 Belvedere Street, Arcadia, Private Bag X79, Pretoria 0001

Dr D.M. Scotney: Director
Mr H.M. du Plessis: Deputy Director
Dr J.F. Eloff: Deputy Director
Dr A.J. van der Merwe: Deputy Director
Mr J.E. Volschenk: Deputy Director

The Institute is responsible for the classification of the resources soil and climate of the Republic as well as basic research to promote the efficient utilisation of soil, water and fertilisers, to identify problems in this regard and to find answers to these problems with a view to the improvement of agricultural production and the protection of the resources soil and water. Soil surveys for irrigation projects and investigations into physical soil properties are also undertaken - particularly where brack and waterlogging conditions occur. In addition, the Institute is responsible for basic irrigation research and the agricultural evaluation and planning of irrigation areas. All agricultural meteorological research and data collection also fall under this Institute and the remote sensing component acts as the specialist centre of the Department. The Institute undertakes the chemical analysis of soil, water and plant material, not only

for this Department but also for other State Departments, Provincial Administrations and other bodies. It is also responsible for the inspection and analysis of fertilisers, stockfeeds, stock remedies and agricultural remedies in terms of Act No. 36 of 1947.

Plant Protection Research Institute
Agriculture Building, Beatrix Street,
Private Bag X134, Pretoria 0001

Dr I.H. Wiese: Director
Dr D.P. Keetch: Deputy Director
Dr V.D. Wasserman: Deputy Director
Dr B.W. Strydom: Deputy Director

The Institute is mainly responsible for advanced research at the national level on plant pathology, insect and animal pests and their control. This includes microbiology, taxonomy of fungi, identification of virus diseases, the freeing of propagation material from viruses, honey-bees, insects in stored grain, forest and timber insects, taxonomy of insects and nematodes, economic zoology, toxicology of insecticides and the biological control of insect pests and weeds. The Institute is also responsible for the examination and control of imported plant material and the control of migratory locusts.

Botanical Research Institute
Private Bag X101, Pretoria 0001

Dr B. de Winter: Director
Dr D.J.B. Killick: Deputy Director

The Institute undertakes basic research on the flora and vegetation of South Africa with emphasis on taxonomy, morphology, ecology and economic botany. The Institute also controls the Botanic Garden at Brummeria (Pretoria) and herbaria in Durban, Grahamstown, Kimberley, Pretoria and Stellenbosch.

Citrus and Subtropical Fruit Research Institute
Private Bag X11208, Nelspruit 1200

Dr J.H. Terblanche: Director
Mr A. van Oostrum: Deputy Director

The Institute is responsible for country-wide research on all aspects of the citrus and subtropical fruit industry, as well as nuts, tea, coffee and herbs.

Tobacco and Cotton Research Institute
Kroondal, Private Bag, Rustenburg 0300

Dr D.J. Rossouw: Director
Dr A. Streutker: Deputy Director

The Institute is responsible for research, including technological research, in the interest of the tobacco industry in all parts of the country.

Horticultural Research Institute
Private Bag X293, Pretoria 0001

Dr J.T. Meynhardt: Director
Dr W.P. Burger: Deputy Director

The Institute is responsible for all applied and fundamental research and specialised extension on vegetables, cut-flowers, ornamental plants and shrubs throughout South Africa. The Institute controls vegetables, flowers and ornamental plant research at Roodeplaat in the Transvaal Middleveld and cherry research at Emperani, near Ficksburg.

Veterinary Research Institute
P.O. Onderstepoort, Pretoria 0110

Dr R.D. Bigalke: Director
Dr C.J. Howell: Deputy Director
Dr D.W. Verwoerd: Deputy Director
Dr B.J. Erasmus: Deputy Director
Dr A. Pini: Deputy Director

The Institute is concerned with research on diseases of stock and game (infectious and others, including diseases caused by malnutrition), diagnostics, the preparation of vaccines and diagnostic aids, and the biological evaluation of dips and remedies submitted for registration.

Animal and Dairy Science Research Institute
Private Bag X2, Irene 1675

Dr J.H. Hofmeyr: Director
Dr J.C. Oosthuizen: Director
Dr P.E. Lombard: Deputy Director
Dr R.T. Naudé: Deputy Director
Dr E.H. Kemm: Deputy Director

The Institute, at various centres throughout the country, undertakes performance and progeny testing at the national level, as well as fundamental research on the breeding, feeding and physiology of farm animals. The Institute is also responsible for dairy and poultry research on a country-wide basis as well as for the training of dairy technologists at Glen.

Fruit and Fruit Technology Research Institute
Private Bag X5013, Stellenbosch 7600

Dr P.G. Marais: Director
Dr P.C. van Rooyen: Deputy Director

The Institute is responsible for research on deciduous fruit, and certain aspects of proteas as well as for research at national level in connection with certain technological aspects of fruits and other agricultural products. The Institute further renders a radiation and radio-isotope service in connection with agricultural problems in the winter rainfall complex.

Viticultural and Oenological Research Institute
Private Bag, Stellenbosch 7600

Dr J. Deist: Director
Mr C. Kok: Deputy Director

The Institute is responsible for all research in the sphere of viticulture and oenology, inter alia, viticultural research in the Lower Orange River area.

Grain Crops Research Institute
Private Bag X1251, Potchefstroom 2520

Dr J.W. Snyman: Director
Dr J. de Kock: Deputy Director (Winter Grain)
Dr K.W. Pakendorf: Deputy Director (Oil and Protein Seeds)
Dr J. Dreyer: Deputy Director (Summer Grain)

The Institute is responsible for research on the improvement and cultivation of summer and winter cereals and high protein seeds and oilseeds.

Directorates

Agricultural Engineering and Water Supply
Private Bag X515, Silverton 0127

Mr C.T. Crosby: Director
Mr F.J.C. Hugo: Chief Engineer
Vacant: Chief Engineer
Mr J. Veenstra: Chief Engineer

The Directorate has a specialised task and devotes itself to all engineering problems in the agricultural industry such as mechanisation (farm power and machinery), soil conservation, water utilisation, farm structures, handling of material, storage of vegetables, fruit and other assigned products, as well as all other engineering services with which the Department is concerned, such as the preparation and development of plots on irrigation schemes. The Directorate also administrates matters concerning bore-hole drilling services, irrigation boards and schemes.

Agricultural Information
Agriculture Building, Beatrix Street,
Private Bag X144, Pretoria 0001

Dr R.J. van Niekerk: Director
Mr Q. Momberg: Deputy Director
Mr L.L. Lötter: Deputy Director

The function of the Directorate is the distribution of agricultural information by means of the mass media. For this purpose use is made of scientific and popular agricultural publications, radio programs, audiovisual aids and press releases. The Directorate is also responsible for the maintenance of an agricultural information bureau.

Biometrical and Datametrical Services
Agriculture Building, Beatrix Street,
Private Bag X116, Pretoria 0001

Dr J.P. Jooste: Director
Mr J.N. de Bruyn: Deputy Director

The Directorate is responsible for bio- and datametrical services to the Department.

Agricultural Production Economics
Agriculture Building, Hamilton Street,
Private Bag X416, Pretoria 0001

Mr J.S.G. Joubert: Director
Mr B.J. van Wyk: Deputy Director

The Directorate's main task is to research the production economics of agriculture and to make known the research results and general production economics principles.

Financial Assistance
Opera-Plaza Building, Bank Lane, Church Square,
Private Bag X118, Pretoria 0001

Mr J. Rademeyer: Director
Mr D. Franken: Deputy Director
Mr R. Johnson: Deputy Director

To provide financial and/or other assistance to deserving farmers and farming enterprises with a view to promoting the agricultural industry by means of loans in terms of various assistance schemes, the sale or leasing of immovable or movable property of the State that is suitable for farming purposes, and the institution of protective measures in the form of the suspension of legal proceedings against farmers pending the possible granting of one or other form of assistance and arranging for farmers to compound with their creditors. The Directorate administers the Agricultural Credit Act (Act 28 of 1966) and the Designated Areas Development Act, 1979 (Act 87 of 1979).

Agricultural Technical Administration
Agriculture Building, Beatrix Street,
Private Bag X116, Pretoria 0001

Vacant:.Director
Mr S.O. Joubert: Deputy Director

Administrative support to management. Administers financial assistance schemes in respect of soil conservation works. Administers subsidies to Irrigation Boards, and to farmers for bore-holes, irrigation works, additional water-works, etc.

Agro-ecological Regions

The seven Regional Organisations of the Department are responsible, within their respective geographical areas, for the planning, development, promotion and application of farming systems based on optimum land use.

Each region provides an extension service in which the soil conservation effort is integrated and which also covers every aspect of farming. The research services are directed to the collation and releasing of scientific knowledge for the optimum use of the natural agricultural resources. The research personnel is also responsible for specialist extension work and for supplying training services to the agricultural colleges.

Highveld Region
Private Bag X804, Potchefstroom 2520

Dr J.D. Slabber: Director
Dr J.E. van Niekerk: Deputy Director (Research)

Dr J.J. Coetzee: Deputy Director (Extension)
Potchefstroom College of Agriculture

Research Stations/Experiment Farms - Potchefstroom complex (central research station), Bethlehem and Swartland (Ventersdorp) (gousiekte research)

Karoo Region
Grootfontein College of Agriculture,
Private Bag X529, Middelburg, C.P. 5900

Dr P.W. Roux: Director
Dr A.J. Siepker: Deputy Director (Extension)
Mr H. Steynberg: Deputy Director (Research)
Grootfontein College of Agriculture

Research Stations/Experiment Farms - Grootfontein, Middelburg, C.P. (central research station), Carnarvon, Tarka Conservation Area, Hales Flats and Jansenville.

Natal Region
Private Bag X9059, Pietermaritzburg 3200

Dr C.N. Macvicar: Director
Mr S.D. le Roux: Deputy Director (Extension)
Dr C.F. Sievers: Deputy Director (Research) Cedara College of Agriculture

Research Stations/Experiment Farms - Cedara (central research station), Drakensberg complex (Estcourt), Northern Natal (Dundee), Kokstad and Pongolapoort (Makatini)

Eastern Cape Region
Private Bag X15, Stutterheim 4930

Dr P.J.S. Pieterse: Director
Dr A.D. Venter: Deputy Director (Research)
Dr D.M. Rix: Deputy Director (Extension)

Research Station - Dohne (Stutterheim) (central research station) and Bathurst (Port Alfred)

A number of experiments are also carried out at East London.

Transvaal Region
Agrivaal Building, c/o Edmund and Hamilton Streets, Private Bag X180, Pretoria 0001

Mr D.F. de Wet: Director
Mr F.F.M. van Aswegen: Deputy Director (Extension)
Dr M.K.S.L. von la Chevallerie: Deputy Director (Research)

Research Station/Experiment Farms - Roodeplaat (central research station), Soutpan (Pretoria), Athole (Amsterdam), Loskop (Groblersdal), Mara (Louis Trichardt), Messina, Nooitgedacht (Ermelo) and Towoomba (Warmbaths)

Free State Region
Glen College of Agriculture, Glen 9360

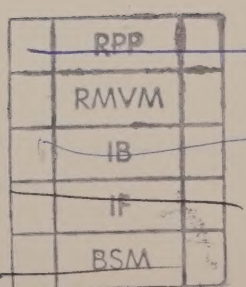
Mr T.E. Skinner: Director
Dr N.J. Robbertse: Deputy Director (Extension)
Dr E.A.N. Engels: Deputy Director (Research)

Research Stations/Experiment Farms - Glen (central research station), Armoedsvlakte (Vryburg), Koopmansfontein (Barkley West), Rietrivier (Herbert), Sandvet, Upington complex and Vaalharts (Jan Kempdorp)

Winter Rainfall Region
Private Bag, Elsenburg 7607

Dr J. de V. Burger: Director
Mr A.F. Kriel: Deputy Director (Extension) Elsenburg College of Agriculture
Mr M.C. Walters: Deputy Director (Research)

Research Station/Experiment Farms - Elsenburg, Mariendal (Stellenbosch), Langgewens (Moorreesburg), Nortier (Lambert's Bay), Oudtshoorn Outeniqua (George), Tygerhoek (Riviersonderend) and the Worcester Veld Reserve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